Combating WMD JOURNAL

U. S. Army Nuclear and CWMD Agency

Issue 1

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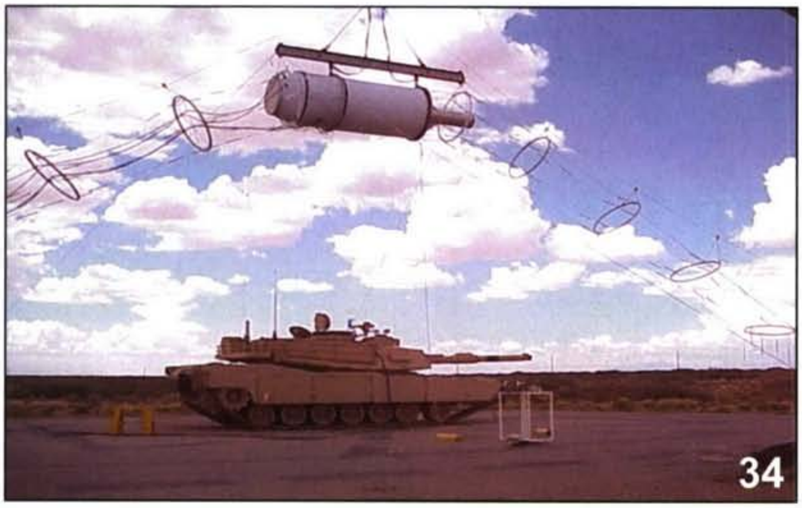

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Army Combating WMD Update

Mr. Peter Bechtel, Director
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Welcome to the first issue of the US Army Nuclear and Combating WMD Journal. Since my last writing, USANCA continues to improve its planning and analysis capabilities to assist the Army Service Component Commands, in coordination and support of the Army Staff. We are also increasingly engaged in the Army's capabilities process, in concert with the Joint Capabilities Integration and Development System (JCIDS) process, and through international forums as well. I want to highlight just a few of the activities and issues our Army is now addressing in these areas.

Current Activities

Two Combating WMD Planning Assistance Teams are forming to assist Echelon Above Corps Army elements with CWMD planning capability. Their initial focus will be the Pacific and domestically in the US. Key to their success is close coordination with the Defense Threat Reduction Planners (for COCOM level integration) and HQDA Strategy, Plans and Policy Elements (for Army Component integration). Additionally, we are providing CWMD subject matter experts to the Battle Command Training Program in support of exercises held at Corps level and above. Information from these interactions is used by USANCA in reviewing Joint Capability documents as well as guiding analysis efforts to better understand the operational impact of specific WMD challenges. One key to successful integration of CWMD tasks and strategy is the consideration of Security Cooperation efforts in light of those called for in the Contingency Planning Guidance. Beyond the obvious 'Phase 0' connection, the demand on Army resources across both areas is viewed concurrently providing a more holistic perspective.

We all must continue to improve the integration of Army-related CBRN materiel survivability capabilities throughout the Defense Acquisition, Technology, & Logistics Life Cycle Management Framework. Army and DOD weapon system programs' capability documents must ensure compliance with Army and DOD survivability standards. We have also developed and are striving to implement the Netcentric Survivability HEMP Improvement Plan (NetSHIP). NetSHIP aims to improve HEMP survivability of mission critical systems and strengthen overall Army CBRN survivability processes. This plan targets improvements through a unified approach to countering electromagnetic environmental effects (E3), a lifecycle sustainment program, and improved integration of CBRN survivability throughout the JCIDS process. We are also assisting the Defense Science Board and Army Science Board initiatives, development of an Army staffing strategy to support the OSD Action Plan for Reducing Vulnerability to EMP, and the development of DODI 3150.cc, The Chemical, Biological, Radiological, and Nuclear Survivability Program. On the international front, the Army's goals are to enhance the capabilities of multi-national forces in CBRN environments and to build partner capacity worldwide. We have been actively pursuing CBRN standardization and interoperability through NATO and American British Canadian Australian (ABCA) program engagement. A NATO team of experts will soon revise STANAG 4521 (AEP-7), NBC Defence Factors in the Design, Testing and Acceptance of Military Equipment, and to develop a set of operational-based CBRN scenarios that can be used as a standard across NATO CBRN forums. Since we do not have a monopoly on all the good ideas, this international involvement is critical to the increased spread of best prac-

tices and can only improve the overall response capability world-wide.

The Nuclear Weapons Effects Database System (NWEDS) upgrade project is in its last year and NWEDS is being incorporated into DTRA's Integrated WMD Toolset (IWMD) and their Nuclear Capability Server (NuCS), thereby designating USANCA's NWEDS code to be the nuclear effects engine for the web-based codes. Internationally, we have assisted in the development of Allied Engineering Publication (AEP)"Radiological Aerosol Challenge Levels" for peacetime operations, the rewrite of STANAG 2473 "Commander's Guide to Radiation Exposure of Groups during War," and revisions of AEP "NATO Handbook for Sampling and Identification of BCR Agents."

In this issue we have continued and expanded our collaborative relationship with other CWMD publications. Three previously published articles are presented in this issue. The good people at NBC International (www.defenceinternational.co.uk), an outstanding publication out of Britain, and the Nuclear Weapons Journal of Los Alamos National Lab have submitted articles that we thought the readers would find interesting. It's important that we engage our community as widely as possible, in order to propagate relevant information and ideas to as many friends as possible. We encourage all readers to participate in this very important discussion by sending us your comments and any information on work you want to express to others. The CWMD community is diverse and we seek to break down some of the stove pipes that still exist.

U.S. ARMY NUCLEAR AND CWMD AGENCY
Fort Belvoir, Virginia

A New Era in Combating WMD

Dr. James A. Tegnelia, Director, Defense Threat Reduction Agency

The President's National Strategy to Combat Weapons of Mass Destruction describes such weapons in the hands of hostile states and terrorists as one of the greatest security challenges facing the United States. This strategy reinforces the need for the Department of Defense (DOD) to continue developing an integrated and comprehensive approach to counter the weapons of mass destruction (WMD) threat. As an essential step toward that approach, the Secretary of Defense assigned the commander, U.S. Strategic Command (USSTRATCOM), as the lead combatant commander for integrating and synchronizing DOD efforts in combating WMD.

The combating WMD mission entails the integration and synchronization of DODwide efforts across the doctrine, organization, training, materiel, leadership, personnel, and facilities (DOTMLPF) spectrum. The President further codified responsibilities and authorities assigned to the USSTRATCOM commander in the Unified Command Plan of May 5, 2006. In answer to this assignment, the commander established the USSTRATCOM Center for Combating Weapons of Mass Destruction (SCC–WMD), which is collocated with the Defense Threat Reduction Agency (DTRA) at Fort Belvoir, Virginia. To support this vital mission further, the Secretary of Defense dual-hatted the director of DTRA as the director of the SCC–WMD. This mission and collocation allow USSTRATCOM and SCC–WMD to leverage DTRA's vast technical expertise.

At the strategic level, preventing hostile states and nonstate actors from acquiring or using WMD is one of the four priorities identified in the 2006 Quadrennial Defense Review (QDR). This is the first time a QDR has devoted such attention to the threat of WMD. Also at the strategic level, the Chairman of the Joint Chiefs of Staff on February 13, 2006, issued the first-ever National Military Strategy to Combat Weapons of Mass Destruction. This strategy builds on the three pillar structure of the 2002 national strategy. As defined in the national military strategy, these pillars are:

- *Nonproliferation*: actions to prevent the proliferation of WMD by dissuading or impeding access to, or distribution of, sensitive technologies, materiel, and expertise
- *Counterproliferation*: actions to defeat the threat or use of WMD against the United States, U.S. Armed Forces, allies, and partners
- *Consequence Management*: actions taken to mitigate the effects of a WMD attack or event and restore essential operations and services at home and abroad.

At the next level, the national military strategy identifies eight mission areas that span the pillars in the national strategy: offensive operations, elimination, interdiction, active defense, passive defense, consequence management, security cooperation and partner activities, and threat reduction cooperation. This new strategic framework is the DOD vehicle for dividing the broad combating WMD mission into specific, definable military activities that better address the DOTMLPF spectrum with more focus on the budget, training, doctrine, and policy processes.

Initially established in August 2005, the SCC–WMD develops and maintains global situational awareness of WMD activities, advocates for combating WMD capabilities, and assists with WMD planning, while shifting emphasis from a DOD-centric approach toward interagency solutions.

The SCC–WMD has faced and overcome many of the challenges associated with standing up a new organization and is making significant progress. It continues to forge enduring relationships throughout DOD and other governmental organizations and has embraced DTRA's existing capabilities and expertise by capitalizing on its traditional areas of chemical, biological, radiological, and nuclear expertise and its longstanding relationships with the combatant commands, Services, national agencies, and other governmental organizations.

The SCC–WMD was declared "fully operational capable" on December 31, 2006, with initial emphasis on the WMD elimination and interdiction mission areas. Elimination supports the systematic seizure, security, removal, disablement, or destruction of a hostile state or nonstate actor's capability to research, develop, test,

French sailors train as part of multinational Proliferation Security Initiative exercise Photo: U.S. Navy (Justin Thomas)

produce, store, deploy, or employ WMD, delivery systems, related technologies, or technical expertise. Interdiction is defined as operations to track, intercept, search, divert, seize, or stop trafficking of WMD, delivery systems, related materials, technologies, and expertise to/from state or nonstate actors of proliferation concern.

SCC–WMD successes in the elimination mission area include the development of a concept of operations that describes the overarching mission area at the strategic level and defines the desired capabilities for both a Joint Task Force–Elimination and the Joint E limination Coordination Element. A capabilities-based document designed to support policy and combatant command planning in the near term (2–7 years), the elimination concept of operations enumerates the roles and responsibilities of DOD components and interagency partners while outlining a construct for operational planning for the elimination mission. The elimination concept is currently out for final general officer/flag officer review and should be published as a handbook in the spring or summer of 2007 by the director of the Joint Staff.

The 2006 QDR directed DOD to establish a deployable joint task force headquarters for WMD elimination that is able to provide immediate command and control for forces executing those missions, as well as expand the Army's 20th Support Command's capabilities to enable it to serve as a joint task force capable of rapid deployment to command and control WMD elimination and site exploitation missions. In support of this task, the SCC–WMD successfully executed the Joint Capabilities Integration and Development System DOTMLPF Change Recommendation process to gain Joint Requirements Oversight Council recommendation for the Joint Elimination Coordination Element, which will be a rapidly deployable, 30-person command and control component capable of augmenting either an established joint force component command or joint task force headquarters specifically tasked to conduct WMD elimination operations. It will also coordinate with combatant commands, components, Services, Defense agencies, and units that may conduct WMD elimination missions on a day-to-day basis for WMD elimination training and exercise support.

The SCC–WMD is also leading USSTRATCOM support for the WMD interdiction mission and Proliferation Security Initiative activities. In support of the WMD interdiction mission, center personnel provide support to the Office of the Under Secretary of Defense (Policy), Chairman of the Joint Chiefs of Staff, and combatant commands to implement the 2006 QDR unity of effort paradigm in coordination with the National Counterproliferation Center and several National Security Council–established interagency forums focused on the WMD interdiction mission. The center also provides operational and exercise support for Proliferation Security Initiative activities and exercises, most recently as a participant in Exercise Leading Edge 07, which focused on maritime interdiction.

To track all of these efforts, the SCC–WMD maintains 24-hour situational awareness of critical combating WMD efforts and information. Combating WMD situational awareness is achieved through fusing regional expertise, open source knowledge, and technical information; connecting evidence, knowledge, and information related to past and current events; then applying analytical rigor to anticipate future events. The DTRA Operations Center's 24/7 collaborative environment supports the SCC–WMD and facilitates tracking of WMD operations by depicting these events globally through a common operational picture, which went online at the classified level in the spring of 2007. The combating WMD common operational picture will provide a Web-based forum for community planners, analysts, and decisionmakers to increase awareness of global combating WMD activities and to serve as a one-stop shop for global combating WMD situational awareness.

As the threat of WMD proliferation grows, the SCC–WMD stands ready to meet the challenges. Through innovation and collaboration, the center is helping members of the WMD community to anticipate, counter, and respond to threats. The SCC–WMD leadership and personnel understand the need for constant vigilance, and they share the President's vision to protect the United States, its forces, and allies from weapons of mass destruction.

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CBRNE Corps and Combating WMD – A "Not-So-Modest" Approach

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COL Robert D. Walk proposed the creation of a new Chemical, Biological, Radiological, Nuclear, and High Explosive (CBRNE) Branch - the Army CBRNE Corps - in an article published in the *Army Chemical Review* (A Modest Proposal: Shatter the Retorts, Defuse the Bomb, and Stabilize the Atom!). [1] This Corps would be an amalgamation of the current Explosive Ordnance Disposal (EOD) sub-specialty, Chemical Branch, and Functional Area (FA) 52 Nuclear and Counterproliferation officer Corps. The purpose of this article is to further examine the CBRNE Corps concept as well as alternative solutions that recognize both the new Combating WMD (CWMD) paradigm adopted by the Army and the unique training and educational requirements necessary for officers to perform in assignments – particularly at strategic levels within DOD. This article, however, limits its focus to the respective officer Corps involved in CWMD – as FA52 does not have enlisted personnel – and discussion of NCOs within the EOD sub-specialty is an additional complication.

Combating WMD – The Approach

The National Military Strategy (NMS) to Combat WMD, published in 2006, lays out a comprehensive approach to deal with the complex and broad scope of WMD proliferation and potential use by US adversaries.[2] This strategy uses the three pillars of Nonproliferation (NP), Counterproliferation (CP) and Consequence Management (CM) described in the 2002 National Strategy to Combat WMD, and identifies eight mission areas: Security Cooperation, Threat Reduction, Offensive Operations, Active Defense, Passive Defense, Interdiction, Elimination, and Consequence Management (Figure 1).[3]

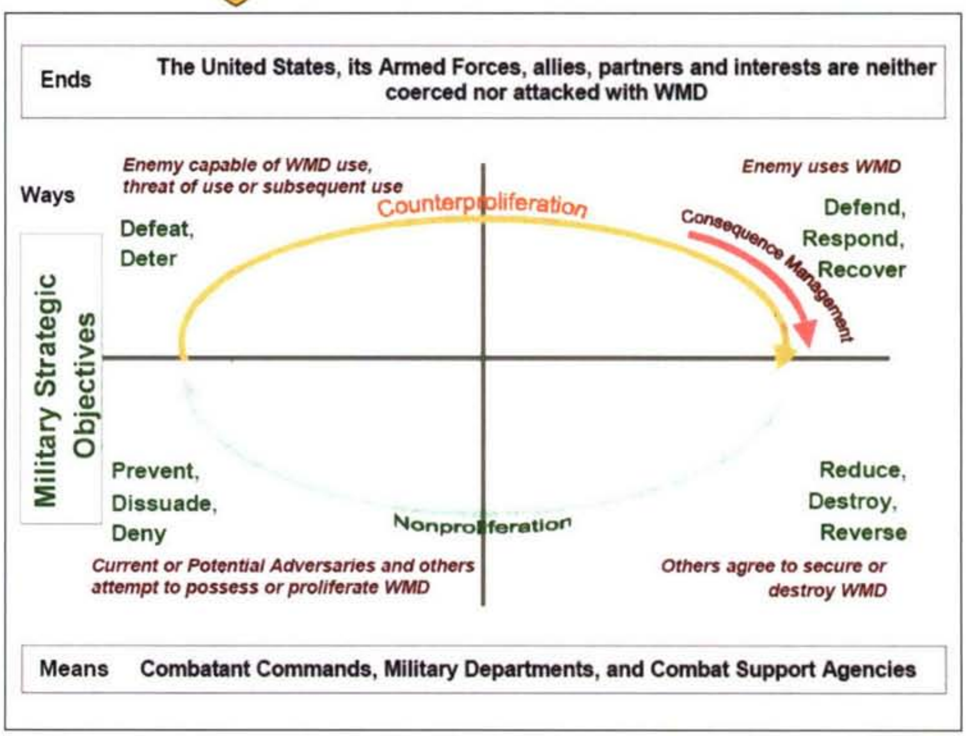

Figure 1. CWMD Approach is outlined in NMS.

This strategy acknowledges the potential synergy between the seemingly disparate approaches of NP, CP and CM. It also recognizes that together, the eight mission areas provide a stronger approach than when executed individually (Figure 2). While there may be disagreement as to the efficacy of this approach, this strategy does, in effect, describe a seamless and holistic environment that leverages the unique contribution of each pillar/mission area.

Organizational changes as a result of both National and Military Strategies to CWMD have been significant. The May 2006 Unified Command Plan assigns US Strategic Command (USSTRATCOM) the responsibility to serve "...as lead combatant commander for integrating and synchro-

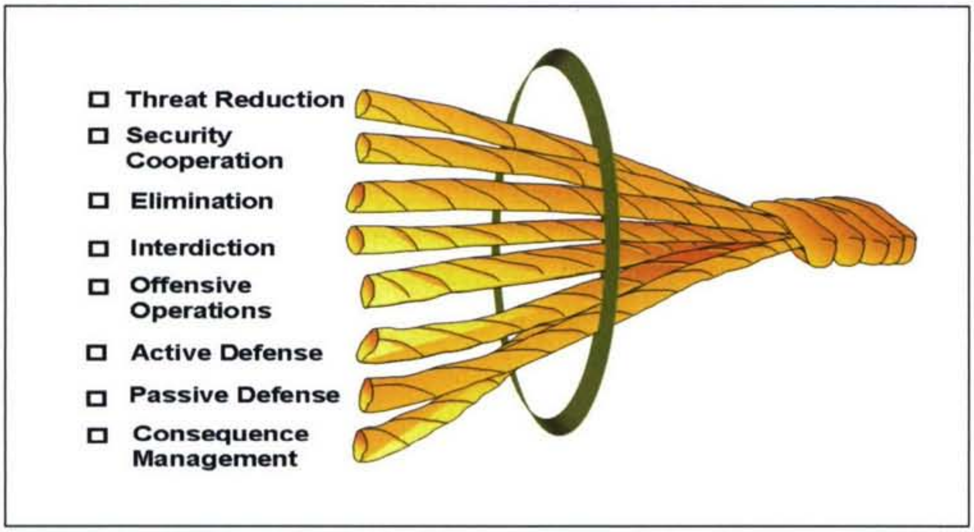

Figure 2. Interfusion of CWMD mission areas.

nizing DOD CWMD efforts...",[4] and OSD, Joint, Air and Navy Staffs have reorganized to include specified CWMD organizations. These reorganization efforts have not resulted in a complete centralization of CWMD efforts within respective levels of DOD, however, they do represent a significant improvement. In certain cases, personnel and expertise shortfalls dictate leveraging 'sister' organizations focused on specific mission areas (e.g., Homeland Defense, Ballistic Missile Defense). While one may hope for complete centralization of expertise and responsibilities to enable 'one-stop shopping', personnel constraints and political sensitivities will likely serve as insurmountable roadblocks.

Anticipating the NMS approach, and recognizing the lack of an integrated articulation of concepts and policy for Army CWMD efforts, the Deputy Chief of Staff, G-3/5/7 reorganized and refocused the National Security Policy Division within G-35 on 1 October 2005. It became the Combating WMD and Proliferation Policy Division (DAMO-SSD) with the principal mission of "...developing Army CWMD and proliferation policies consistent with national strategy...." The intent of this new organization is to provide an Army Staff (ARSTAF) focal point for CWMD; however, there was no intent to duplicate CBRN functions already being performed by other ARSTAF organizations. Leveraging other Divisions' expertise and responsibilities was expected and necessary due to similar personnel and resource constraints facing all DOD organizations. This reorganization, in conjunction with the reassignment of the US Army Nuclear and CWMD Agency (USANCA) as a G-3/5/7 CWMD Field Operating Agency (FOA), demonstrated G-3/5/7's commitment to approach CWMD holistically, and allows for appropriate cognizance of and facilitation for multiple programs supporting Army CWMD efforts. It also provides for improved interface across multiple levels of the Army and DOD, and formulation of coherent Army CWMD strategies and policies, articulated via the components of The Army Plan (TAP). This will ultimately inform appropriate Army Commands as they develop DOTMLPF solutions pertaining to Army CWMD capabilities – with "P" (personnel) most germane to the focus of this article.

Army Officer Corps Supporting CWMD Missions

Before responding to COL Walk's specific recommendations for adjustments in officer assignments to support CWMD, it is important to identify Army officer Corps specialties that are involved in CWMD efforts/mission areas. It is also important to note that the full-range of CWMD functions is *shared* by multiple entities, supported by various Branches and FAs. Though the list (Table 1) of specialties and specified mission areas is not necessarily comprehensive, it does give one an appreciation for the scope/breadth of CWMD. This scope/breadth also highlights another important distinction: just as combat arms operations require careful balance and leveraging of unique armor, infantry, and fires skills; CWMD requires the same leveraging - albeit for CBRN expertise. In short, CWMD is broad, multidisciplinary and complex, and requires an approach that leverages multiple officer competencies through cooperation, coordination and integration of effort – informed by clearly articulated Army CWMD concepts and doctrine. Merging of unique skills is not necessarily the best answer.

It is also important to note the distinction between a Branch, a Branch's associated sub-specialties and Functional Areas (FA). COL Walk's proposal merges all three into a single CBRNE Branch; however, he fails to note potential second and third order effects resulting from this merger. A Branch assesses its officers as Second Lieutenants, providing initial training and company grade experience at tactical levels. Their development continues through operational experience, military education and training within their respective Branch, and culminates with field grade assignments at tactical, operational and strategic levels. Senior O-3 officers may choose to 'single-track' in the operational career field and continue the remainder of their career in their Branch. A sub-specialty within a Branch (e.g., EOD within the Ordnance Branch) provides officers additional training in order for them to perform specific functions within their respective Branch. FA officers are assessed later in their careers (at the senior O-3 level) through a centralized process, are usually offered advanced civil schooling within their specialty, and are given follow-on assignments as field grade officers primarily at operational and strategic levels.

Though COL Walk's approach is novel, his proposal does not recognize the unique contributions of the respective Branches and FAs involved in CWMD. He tacitly dismisses the rationale behind the or-

Table 1. Listing of Branches and Functional Areas Supporting CWMD.

Branch/FA	CWMD Mission Area
Branch 14 – Air Defense Artillery	Active Defense
Branch 15 – Engineers	CWMD Enabler
Branch 18 – Special Forces	CWMD Enabler
Branch 35 – Military Intelligence	CWMD Enabler
Functional Area 40 – Space	Active Defense
Functional Area 52 - Nuclear and CP	Offensive Operations, Threat Reduction, Interdiction and Elimination
Branch 67 - Medical Service 67C - Preventive Medicine Sciences 67C/72A - Nuclear Medical Science	Passive Defense and CM
Functional Area 71 – Medical 71A - Microbiology 71B – Biochemistry	Passive Defense and CM
Branch 74 – Chemical 74A - Chemical, General 74B - Chemical Operations and Training 74C - Chemical Munitions and Materiel Management	Passive Defense, Interdiction, Elimination, Security Cooperation, Threat Reduction, and CM
Branch 89 – Ordnance • 89E - Explosive Ordnance Disposal	CWMD Enabler

ganizational approach adopted by designers of the current Officer Professional Management System (OPMS), and fails to adequately describe shortfalls with the current system before laying out a rather dramatic (vice modest) proposal – particularly for the EOD and FA52 Corps. He appears to base his proposal on "...insufficient chemical positions to cover higher-level staff requirements."; "...high demand for (EOD) skills and (their inability to) provide the needed explosive coverage."; FA52 lack of "...the broad background in CBRN operations that chemical officers possess."; and the overall assessment that the Chemical, EOD and FA52 Corps "... represent the continuance of Cold War ideas and may not represent the best fit for today's modular Army." [5] His article did not discuss the "B" in the CBRNE Corps concept – surprising in light of the medical community's role in the CWMD regime and the 2006 Quadrennial Defense Review (QDR) decision to shift considerable funding to biological defense research at the expense of chemical programs. [6] Similarly, inclusion of "E" in this proposed Corps appears to contradict efforts by Joint Staff and the Combating WMD community to focus on CBRN matters – particularly in Counterproliferation (CP) and Consequence Management (CM) arenas – vice attempting to incorporate high explosives (e.g., truck bombs) or an 'all-hazards' approach (e.g., hurricane relief operations) for CM.

Can all three officer Corps be merged? In theory – yes, but in practice such a merger would be very difficult, and likely detrimental to the original purpose for each Branch/subspecialty/FA as well as for the officers themselves. For example, merging a FA into a Branch effectively eliminates the FA as designed under OPMS. This option should be considered only if one believes the capability provided by the effected FA is no longer required. FAs were established to create highly specialized officer Corps - leveraging tactical experience and providing additional graduate-level education – to support specific Army requirements, but also allowing for the same promotion opportunities as officers in the more traditional 'operational' career field. Similarly, sub-specialties within a Branch such as 89E provide additional training on particular skills in order to provide additional expertise in execution of critical Army missions. FA and sub-specialty managers generally have an advantage by working with smaller number of officers (~160 FA52s and 275 EOD officers). This allows them significant flexibility in adapting to emerging 'customer' requirements, and also provides a unique opportunity for advanced civil and military schooling that many Branches simply cannot provide nor afford due to operational requirements. With these facts in mind, the potential result of creating a CBRNE Corps -- essentially eliminating FA52 and the perhaps diminishing the capabilities provided by the EOD subspecialty – might be CBRNE officers who are "jack of all trades and master of none". [7]

What Requires Improvement?

It does not seem that any Branch, sub-specialty or FA that supports CWMD missions are 'broken', and therefore requires 'fixing'. For example, FA52 is, by any measurement, a successful FA. The FA52 proponent (G-3/5/7's US Army Nuclear and CWMD Agency) sends more than 70% of its assessed officers to advanced civil schooling for highly technical degrees ranging from physics to nuclear engineering – including PhDs. It has an OPMS 'pyramid' or grade ratio that allows for a tremendous promotion opportunity for offi-

cers at all field grade ranks. COL Walk's article also perpetuates misconceptions regarding the FA52 officer Corps: 1) FA52 represents the continuance of Cold War ideas; 2) that FA52 officers working at higher level staffs are there due to the scarcity of Chemical officers, and FA52 responsibilities were expanded solely to fill a niche formerly overseen by the Chemical Corps; and 3) FA52 officers do not possess the breadth and experience required to perform at these levels.

First and foremost, FA52 officers provide a unique capability to DOD and Interagency organizations that is hardly 'Cold War'. FA52 officers focus primarily on *offensive* operations – both nuclear and conventional operations against WMD-related targets – leveraging Branch tactical and operational experience, and translating this into valuable advice and products at the strategic level. Yes, the Army gave up its nuclear weapon arsenal following a Presidential Nuclear Initiative in 1991; however, nuclear weapons remain an important part of the New Triad as described in the 2001 Nuclear Posture Review. FA52 officers represent the only officer Corps in DOD specifically designed to possess training and education in nuclear weapon and reactor design, nuclear physics and nuclear weapon employment. This capability readily translates to a number of post 9/11 requirements throughout DOD and the Interagency community within several mission areas of CWMD.

Secondly, FA52 customers – Combatant Commands (COCOM), Defense Agencies, OSD, and Joint Staff – articulate their requirements for skills regarding officer billets to the respective Services. While COL Walk infers that the Chemical Corps may have challenges associated with filling these billets to the levels required by the respective organizations, it is an unfair characterization to state that these organizations are adding or recoding billets to FA52 or other specialties as a result. Nuclear focused organizations (Domestic Nuclear Detection Office, USSTRATCOM, divisions within the Defense Threat Reduction Agency, and Assistant to the Secretary of Defense (Nuclear Matters)) have made a concerted effort to retain or increase the number of FA52 billets, and these decisions had nothing to do with capabilities or skills provided by US Army Chemical Corps officers. These organizations, as well as other organizations less focused on nuclear issues, appear very satisfied with the FA52 officers filling their respective positions, and the demand for FA52 expertise is increasing as measured by increased authorizations. FA52 officers are not trained to have equivalent expertise in CB defense as Chemical or medical officers; however, they do possess expertise in kinetic offensive operations against WMD-related targets not readily replicated by Chemical or Medical Corps officers.

Finally, the implication that FA52 officers' lack of a "...broad background in CBRN operations..." [8] renders them less qualified to perform in higher-level staff positions is unfair. FA52 officers are highly qualified to assume strategic CWMD positions within the Army, the Joint community and OSD. Indeed, no single CWMD specialty can accurately lay claim to possessing a depth of expertise obtained from years of education, training and operational experience in multiple disciplines; however, this depth is not necessarily a prerequisite to success at the operational and strategic levels of DOD.

Similarly, the EOD Corps appears to be extremely successful in developing highly qualified professional officers, and now are a 'text book' example of success within the Ordnance Corps. Formerly relegated to the 'backwaters' of strategic and operational thinking, current combat operations have made terms such as IED (Improvised Explosive Device), EFP (Explosively Formed Penetrator) and CEXC (Combined Explosive Exploitation Cell) commonly used terms in operational lexicon. EOD (89E) officers have a successful career path recognized by personnel officers as attributable to a strong pyramid of progression. This is in sharp contrast to the situation 20 years ago when Ordnance officers alternated between ammunition and EOD billets - as a result, Maintenance officers typically stole the limelight. In fact, the 89E career field is a 'growth industry' – growing from a sub-specialty fundamentally 'capped out' at Lieutenant Colonel with a large handful of majors and approximately 50 Captains in either staff or detachment command positions. EOD opportunities now include seven CSL battalion commands and two CSL group commands. Now, EOD officers are assigned to G3 staff from Division to Army Service Component Command level. [9]

First and foremost, FA52 officers provide a unique capability to DOD and Interagency organizations that is hardly 'Cold War'. FA52 officers focus primarily on offensive operations – both nuclear and conventional operations against WMD-related targets – leveraging Branch tactical and operational experience, and translating this into valuable advice and products at the strategic level.

The Chemical Branch has the unique distinction within the Services as being the only Branch with a specified mission to provide maneuver commanders personnel with a high degree of training and expertise in order for units to operate and survive in a CBRN environment. Department of the Army Pamphlet 600-3 [10] clearly describes the Chemical Branch's primary focus as CBRN *defense*. This translates into support for

commanders and staffs particularly in CWMD mission areas of Passive Defense and Consequence Management. To this end, the Chemical Branch is making significant strides in training, doctrine and organizational changes in response to operational experience and changing Army priorities.

So what requires improvement? A very real problem was tangentially broached by COL Walk - insufficient CBRN billets – particularly on Combatant Command and other strategic level staffs. This, however, is a Joint problem not readily solved by a merging of Army officer Corps, but only can be addressed by senior leadership responsible for these staffs. For example, most geographic COCOMs have a single Chemical Corps officer (O-5) assigned to their staff. This shortfall cannot be mitigated by assignment of a newly minted CBRNE Corps officer responsible for the entire breadth of CWMD. The ability of a Branch, sub-specialty or FA to assign sufficient numbers of officers is another issue. Though adding additional officers to a Chemical /CBRNE Corps (e.g., 89E and FA52) might appear to be a viable course-of-action, it assumes that the new Branch will adequately train and educate these officers to handle the diverse roles and responsibilities inherent in CWMD mission areas. Though COL Walk acknowledges that creation of a new Branch must be done carefully, and that no one entity should have "...a disproportionate amount of power...", [11] the fact remains that the Chemical Corps officer pool size and influence currently far exceeds those of 52s and 89Es. If the issue is lack of Chemical billets available for CBRN assignments at higher echelons, there may be a strong temptation to use 89E or FA52 billets (to be recoded 'CBRNE Corps') to fill the gap – at the expense of the organizations relying on the current expertise these officers provide.

Even if the Army addressed the apparent shortfalls in creating and filling CBRN billets at higher-level staffs, there is a more pressing issue: a lack of coherent Army concepts, policy and doctrine that addresses all three pillars and eight mission areas in a holistic fashion. The CWMD entities identified in Table 1 undoubtedly are addressing their respective 'piece' of CWMD across DOTMLPF in an outstanding manner; however, there does not appear to be a concerted effort in HQDA to *prioritize* efforts, requirements and capability development across the spectrum of CWMD. There appears to be an apparent 'disconnect' between concepts (G-35), requirements (G-37), and capability development (G-8) insofar as Army CWMD efforts are concerned.

Solutions

First and foremost, open and frank dialogue between the stakeholders within the CWMD officer Corps is critical. Interpretation and rebuttal of articles and DA PAM language does not appear to be an effective approach. Dialogue between members of respective Branch/sub-specialty/FA Council of Colonels would be a prudent start, and would be viewed as less 'threatening' than a more direct approach through official channels with inevitable staffing actions. Through a careful and, if necessary, lengthy process, the stakeholders may find common ground, and provide Army senior leaders with prudent and practical options to improve the effectiveness of the CWMD officer ranks.

The creation of the Combating WMD and Proliferation Policy Division and ACCWMD within G-3/5/7 was undertaken to address the lack of concepts and policy emanating from HQDA regarding CWMD, but there remains a great deal of work to be accomplished to breakdown the persistent 'stove-piping' occurring within a number of Army CBRN programs and organizations. To this end, there must be better communication and coherent effort between the Army organizations charged with Army CWMD policy, requirements, and capability development. Application of Lean Six Sigma (LSS) principals to the CWMD-related piece of the concepts-to-capabilities (C-C) process would be a prudent start and, as previously mentioned, insertion of appropriate language into TAP would inform ARSTAF and Army Commands regarding the Army's strategic direction in CWMD.

To address the lack of CBRN billets on COCOM, OSD or Joint staffs, there should be a concerted effort to carefully scrub COCOM billets to identify potential conversion opportunities – keeping in mind that CWMD is not an Army-only problem. The Navy, Air Force and Marines contribute personnel to high level DOD staffs with a WMD focus; though admittedly they do not necessarily have a specified WMD 'specialty'. The addition of an EOD, Chemical and/or FA52 officer to augment the existing Chemical officer on a higher-level staff with limited CBRN billets (through conversion of an existing O1A or O2A billet) would increase capability, and provide synergy by leveraging existing expertise.

The Chemical Branch has the unique distinction within the Services as being the only Branch with a specified mission to provide maneuver commanders personnel with a high degree of training and expertise in order for units to operate and survive in a CBRN environment.

Though DA PAM 600-3 offers a description of roles and responsibilities for each respective Branch, FA, and sub-specialty, and recognizing that renaming is clearly not a panacea to solve problems, one might consider a renaming convention in order to more clearly identify the respective Corps' to the Joint commander seeking a particular skill-set. For example, the Chemical Corps could be renamed to the "CBRN Defense Corps" – in recognition of their passive defense focus and operational-response capability against CBRN hazards.

Likewise, FA52 "Nuclear and Counterproliferation" could be renamed "Nuclear CWMD" in recognition of its primary focus on nuclear weapons, their employment and effects, and application of these skills to other CWMD mission areas including offensive operations (nuclear and non-nuclear) against WMD sites.

No matter what problem one feels is pertinent to current Army CWMD issues, the Army should consider the effects it wants to achieve before reaching into the solution kit-bag. If the desired end-state is appropriate numbers of CBRN billets on respective staffs, and sufficiently trained and focused officers to fill them, then merging of Branches and FAs is not necessarily the best approach.

Conclusion

CWMD is a broad and conceptually complex subject. For this reason alone, there is no 'silver bullet' or panacea to resolve the multiple issues and challenges facing the Army in this arena. Additionally, while there is a relative dearth of CBRN specialists to populate sufficient numbers of Army, Joint Staff, OSD and Interagency billets, merging of three distinct officer Corps with complimentary capabilities is not necessarily the best answer. Increased dialogue between Army CWMD stakeholders and an effort to improve efficiencies within current higher-level staffs – keeping in mind the purpose of the new OPMS construct – is a prudent start.

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ENDNOTES

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[2] Peter Pace, *National Military Strategy to Combat WMD*, Office of the Chairman of the Joint Chiefs of Staff, 13 February 2006, 7-11.
[3] George Bush, *National Strategy to Combat WMD*, White House, December 2002, 2-5.
[4] George Bush, *Unified Command Plan*, White House, 5 May 2006, 12-15.
[5] Walk, "A Modest Proposal", 35.
[6] Donald Rumsfeld, *2006 Quadrennial Defense Review*, Office of the Secretary of Defense, 6 February 2006, 52-53.
[7] Howard Rudat, [howard.rudat@hqda.army.mil], "RE: Article." Private e-mail message to David Fiely, [david.fiely@hqda.army.mil], 26 October 2006.
[8] Walk, "A Modest Proposal", 35.
[9] Rudat, "Private e-mail message".
[10] *Department of the Army Pamphlet 600-3*, Headquarters Department of the Army, 28 December 2005, 242-252.
[11] Walk, "A Modest Proposal", 37.

Combating Weapons of Mass Destruction Educational Programs at the Air Force Institute of Technology

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The Air Force Institute of Technology (AFIT), located at Wright-Patterson AFB, Ohio, has a long history of educating military officers. The Institute traces its roots starting in 1919 from the Air School of Application at McCook Field in Dayton, Ohio. With the creation of the Army Air Corps in 1926, the school was renamed the Air Corps Engineering School and moved to Wright Field. When the Air Force became a separate service in 1947, the Institute was renamed the Air Force Institute of Technology. Today, AFIT falls under the Air Force's Air University as part of Air Education and Training Command.

The overall mission of AFIT is to provide responsive, defense-focused, education, research, and consultation to improve Air Force and joint operational capability. AFIT provides both graduate level education and continuing professional education through three schools: the Graduate School of Engineering and Management, the School of Systems and Logistics, and the Civil Engineer and Services School. All graduate level education is handled through the Graduate School of Engineering and Management. The mission of the Graduate School of Engineering and Management is to produce graduates and engage in research activities that enable the Air Force to maintain its scientific and technological dominance. The school's mission reflects its focus on preparing students with the skills required to maintain the world's best Air Force, with the recognition of research as a critical element in quality graduate education.

Students at AFIT come primarily from the Air Force, but there are also significant numbers of students from the other services as well as government civil servants and surprisingly, some "true" non-government civilian students. There are also students from several foreign countries. Currently, the Graduate School of Engineering and Management is host to over 900 students.

The Department of Engineering Physics in the Graduate School offers Masters of Science and Doctorates of Philosophy degree programs in Applied Physics, Material Science and Engineering, Electro-optics, and Nuclear Engineering. The standard program length for military officers is 18 months for a M.S. and three years for a Ph.D. program. The department also offers compressed one year M.S. degrees available only to Air Force officers selected for Intermediate Developmental Education (this program is equivalent to the Air Command and Staff Course). Prior to beginning their graduate degree, more senior officers that have been out of

Figure 1. Ph.D. candidate MAJ Michael Anderson works with a lead-lined "Pig" and a High Purity Germanium Gamma Spectrometer at the Air Force Institute of Technology Nuclear Engineering Laboratory.

Figure 2. Majors Tom Gray and Lonnie Carlson take data from a Phoswich Detector in the Nuclear Instrumentation Laboratory

the academic environment for an extended time, have the opportunity to take some refresher undergraduate courses at Wright State University (also in Dayton) through a cooperative agreement between the two schools.

The traditional Engineering Physics Department focus on weapons of mass destruction (WMD) has been through the graduate nuclear engineering program. Many current Army Nuclear and Counterproliferation (FA 52) Officers are graduates of this program. In fact, they comprise the bulk of the students in the nuclear engineering program. Research in the nuclear engineering program ranges from basic science and engineering research to more applied and operationally oriented work. Some examples of recent research results include: a study of the sensitivity of fallout calculation codes to input parameters; development of neutron transport codes; performance evaluation of a new field-portable, mechanically cooled, high-purity germanium gamma spectrometer; and a study of weathering effects on uranium oxides for attribution purposes.

With technology changing almost daily, the need to keep education current while anticipating future needs is a demanding role for AFIT. The Quadrennial Defense Review 2006 addresses combating WMD as an important focus and suggests reorienting capabilities to meet defense needs. It specifically discusses combating WMD:

> *The future force will be organized, trained, equipped and resourced to deal with all aspects of the threat posed by weapons of mass destruction. ... The Department will develop new defensive capabilities in anticipation of the continued evolution of WMD threats. Such threats include EMP, man-portable nuclear devices, genetically engineered biological pathogens and next generation chemical agents.*

The National Security Strategy for Combating WMD tasks DOD to:

> *Defeat and deter use of WMD and, if used by an enemy, deter the next use; Protect from, respond to, and recover from WMD use; Defend, dissuade or deny WMD possession or proliferation; and Reduce, destroy or reverse WMD possession.*

A primary tool needed to accomplish these tasks is a well educated force that can fully understand the technologies used in WMD. As part of its responsive educational mission, AFIT is standing up new combating WMD graduate education programs specifically aimed at meeting these tasks.

There is, however, already a plethora of training opportunities now available for individuals under the guise of Combating WMD. Combating WMD programs are cropping up throughout the country. Does it make sense for AFIT to start yet another? The answer is "yes," because several factors make the new AFIT programs distinct from other programs.

The AFIT Combating WMD programs are distinct because it is education, not training; technical not policy; and it is graduate-level education at an accredited institution. Almost all the currently available combating WMD programs around the country focus on either training or on policy. Training programs are generally designed for the first responders, civil support teams, or front-line personnel to prepare them for a WMD event. Very few are focused on education and almost none are taught at the graduate level (certainly none in DOD). The current educational programs are often very elementary and aimed at policy and decision makers rather than designed to grow technical experts. The Defense Threat Reduction Agency (DTRA) Outreach program is an excellent example of an educational program designed to provide familiarization of WMD for decision-makers, but again the technical level is fairly elementary. Policy and strategic studies programs abound and often have a strong educational aspect, but they are not technically oriented. Training, policy studies, and a familiarization with WMD alone are not sufficient to prepare the expert technical advisors, inspectors, analysts or researchers needed in the fight against WMD. AFIT, with a long history of expertise in nuclear effects, and a faculty with a strong military operational experience, is uniquely suited to put together a comprehensive combating WMD educational program.

Figure 3. Assistant Professor LTC David LaGraffe at a Hall Effect Apparatus, Nuclear Engineering Lab, Air Force Institute of Technology.

Starting in the Fall 2006 Quarter, AFIT will begin offering two Combating WMD programs to meet different educational requirements. These two requirements include the need to supply short-term education for people with limited time, and the need to meet long-term educational requirements for people needing advanced degrees. The first program, the Graduate Studies Program (GSP), is a short course leading to an AFIT Graduate Certificate. Although it is not an advanced degree granting program, the GSP does earn the students 16 graduate credit hours. The second is an 18-month Professional Science Master's (PSM) degree program.

Graduate Studies Program

The GSP is one academic quarter (10 weeks) in length leading to an AFIT Graduate Certificate in Weapons of Mass Destruction. Certificate is somewhat of a misnomer for this program as this term is often associated with training, but again the focus here is on graduate level education in the technical aspects of WMD technology. The GSP is designed to meet the educational needs of a person newly assigned to a WMD related position who lacks the requisite technical background. An example student would be an Air Intelligence officer with an undergraduate degree in mathematics newly assigned to the Southwest Asia WMD desk at DIA. The goals utilized during the design of the GSP were to develop an educational program that would enable the students to achieve the *knowledge, comprehension,* and *application* levels of Bloom *et al's* taxonomy of cognitive learning.[2] *Knowledge* is defined (here) as the remembering of appropriate, previously learned information. *Comprehension* is grasping the meaning of informational materials. *Application* is the use of previously learned information in new and concrete situations to solve problems that have single or best answers. Job positions requiring an understanding beyond these levels would ideally be filled by a person with specific education or expertise in WMD (such as a graduate of AFIT's master's degree program).

As designed, the GSP consists of four courses taken simultaneously. Three of the courses will each specifically address nuclear, chemical and biological weapon technologies. The fourth course, the Combating WMD *Practicum*, consists of a combined seminar, laboratory and exercise course designed to emphasize operational aspects of the material. By necessity, each of the nuclear, chemical and biological courses is somewhat stove-piped in its presentation of material. However, the curricula are organized so that each course will be covering the same *types* of material at the same time. For example, all three courses will cover mitigation at the same time. One goal of the seminar course is to provide a unifying backdrop to the other three courses.

Each of the three main courses nuclear, chemical and biological (N, C, and B), will individually cover the scientific foundations, production, weaponization and effects, and protection and mitigation. Examples of coverage of the foundations are nuclear structure, cell physiology and chemical reaction kinetics. Example topics in production are the nuclear fuel cycle, fermentation and dual use chemical precursors. Example weaponization and effects coverage are electromagnetic pulse effects, agroterrorism and defoliants. Examples of protection/mitigation topics are radiodosimetry, biosensors and medical prophylaxis.

There is a lot of interest in distance learning education at this time and the GSP is an excellent candidate to offer in this manner. However, as a new program, the GSP is currently only offered in-residence at Wright-Patterson AFB. AFIT is hoping to develop the program enough to offer the GSP as a distance learning choice over the next two to three years.

Professional Science Master's Degree Program in Combating Weapons of Mass Destruction [3]

Some readers may be unfamiliar with the concept of a Professional Science Master's Degree (PSM). It is a relatively recent trend in academics, but has achieved widespread acceptance. The PSM was developed in response to studies demonstrating the need for science and math oriented "professional" master's degree-level education. "Professional" indicating that graduates would be best prepared for a career in the industrial and government employment sectors as opposed to academics. Traditionally, the Ph.D. has been perceived as the only significant gateway to career

opportunities in math and science – and academics as the only career path. The PSM represents a shift towards programs that prepare graduates for non-teaching careers. It also offers an alternative model to combat the common perception of a Master of Science as the "default" degree of a failed Ph.D. attempt.

PSM degrees are recognized by the American Council of Graduate Schools. There are nearly 100 PSM degree programs currently offered by institutions such as Stanford, Case Western, Rice, Michigan State and Boston Universities. There is a wide variation with curricula and structure among PSM programs. Each is designed to prepare graduates for success in the business or government fields rather than further academic study. This is the "professionalization" aspect of the programs. Although each PSM program is individually designed to meet specific goals, some common themes are:

- An inter- or multidisciplinary nature to course work.
- Certificates, within or in addition, are a common element
- Allows "focusing" or "specialization" within latter portions of program
- Uses a "cohort" model for students to develop teamwork
- The use of case studies and group projects
- A few are "entrepreneurial" in nature
- Research is closely linked with business or government organizations
- Inclusion of an oral examination or exit interview
- Graduates place in traditional industries (vice academics)

As will be discussed later, the AFIT PSM Degree Program in Combating WMD is designed along these same themes. Further information on PSM programs can be found at the Science Masters web site.

The AFIT PSM Degree Program in Combating Weapons of Mass Destruction is a six-academic quarter (18 month) degree program as is typical of other AFIT masters programs. Graduates of the program will have established a broad base of knowledge in all areas of WMD and will have demonstrated the ability to conduct research in a specific area of WMD. The goals utilized during the design of the MS program were to develop an educational program that would enable the students to achieve the *analysis, synthesis* and *evaluation* levels of cognitive learning. *Analysis* is the breaking down of informational materials into their component parts, examining such information to develop divergent conclusions by identifying motives or causes, making inferences, and/or finding evidence to support generalizations. *Synthesis* is creatively or divergently applying prior knowledge and skills to produce a new or original whole. *Evaluation* is judging the value of material based on personal values/opinions, resulting in an end product, with a given purpose, without real right or wrong answers.

Developing this level of learning in all three areas; nuclear, chemical and biological is an unachievable goal. What is realistic is to develop a broad scientific base of knowledge in each area with specific, advanced expertise in one of them. Students will first start establishing this broad base of knowledge in the first quarter of the program. Completion of the GSP is part of the first quarter – the certificate element of a PSM. Additional interdisciplinary course work continues the PSM theme in later quarters. In quarters two through five, students will also spend time in their focus area, biological, nuclear or chemical. Students will take a four course sequence and four other electives in their specialty area. This is the period where they gain the in-depth understanding of a specific area. This period of study will also lead to a research project completed during their fourth through sixth quarters. This research project is professionalized to the greatest extent possible in coordination with customer organizations like DTRA, Air Force Technical Applications Center, and the Air Force Nuclear Weapons and Counterproliferation Agency. Many of the skills and abilities gained in the program, such as the ability to conduct advanced research, use of the scientific method, and a host of experimental and mathematical skills, are applicable in all three areas and reinforces the multidisciplinary approach of the program.

Finally, during their sixth and last quarter, the students will take a capstone course. The content of the capstone course is based loosely on the Department of Homeland Security's Five Cities Study. The goals of the capstone course are to once again present a unified (N, C and B) approach to combating WMD and to prepare graduates to be technical advisors. The capstone course is group-oriented and project-oriented emphasizing the teamwork and group project orientation of a PSM.

Figure 4, (see following page) shows sample educational plans students may embark upon. At the outcome of the program, students will have conducted research in a specific specialty area, and will have established a broad enough educational base to be a versatile combating WMD advisor rather than just say a biological warfare specialist.

A valid argument may be made that this program is developing a "Jack of all trades, Master of none." However, the realities of personnel manning requirements needs to be addressed. Most organizations cannot afford to support separate biological, chemical, and nuclear experts. An expert in any of these areas is frequently asked to provide advice or guidance in the other areas – regardless whether they know anything or not! The intent of this program is to recognize this limitation and address it.

Graduates will have a reasonable level of expertise in one track, yet still have enough understanding in the other areas to provide sound advice or know how to get the correct information.

Nuclear Track	Chemical Track	Biology Track
Fall	**Fall**	**Fall**
Nuclear Weapon Technology	Nuclear Weapon Technology	Nuclear Weapon Technology
Chemical Weapon Technology	Chemical Weapon Technology	Chemical Weapon Technology
Biological Weapon Technology	Biological Weapon Technology	Biological Weapon Technology
Computational Modeling of WMD	Computational Modeling of WMD	Computational Modeling of WMD
Winter	**Winter**	**Winter**
Nuclear Instrumentation	Environmental Chemistry	Immunology
Nuclear Explosives	Probability & Statistics	Probability & Statistics
Probability & Statistics	Atmospheric Transport	Biotechnology I
Spring	**Spring**	**Spring**
Radiation Health	Environmental Monitoring	Radiation Health
Nuclear Applications Elective	Chemical Applications Elective	Biology Applications Elective
Nuclear Applications Elective	Chemical Applications Elective	Biology Applications Elective
Summer	**Summer**	**Summer**
Nuclear Chemical Engineering	Environmental Organic Chemistry	Biotechnology II
Risk Modeling and Analysis	Risk Modeling and Analysis	Risk Modeling and Analysis
Thesis Research	Thesis Research	Thesis Research
Fall 2	**Fall 2**	**Fall 2**
Thesis Research	Thesis Research	Thesis Research
Winter 2	**Winter 2**	**Winter 2**
CAPSTONE Course	CAPSTONE Course	CAPSTONE Course
Nuclear Applications Elective	Chemical Applications Elective	Biology Applications Elective
Thesis Research	Thesis Research	Thesis Research

Figure 4. Example six quarter education plans for each possible track.

Despite the increased development of many WMD training and familiarization programs, there is still a gap in advanced, graduate-level, technical education in weapons technology. Leaders, program managers, researchers and operators will need the educational background to stay on top of the vast and ever changing WMD issues present in our current military missions. The AFIT Graduate Certificate program will meet the needs of a person who has a technical background and needs additional specialization in WMD technology. The PSM program fills the need for DOD to grow technical expertise in combating WMD. The fight against WMD will be an enduring one and it is vital that we commit the resources to develop the technical expertise and advisors for now and in the future.

People interested in taking either of AFIT's Combating Weapons of Mass Destruction programs should contact:

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ENDNOTES

Information on the DTRA Outreach program is available on the DTRA website: http://www.dtra.mil.

[2] Bloom B. S. (1956). Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain. New York: David McKay Co Inc.

[3] Information on the PSM in general is available at: http://www.sciencemasters.com/; listings of specific programs are also available at: http://www.gradschools.com/.

Respiratory Protection Guidance During a Radiological Emergency Response

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The authors have noted that there are several publications and Department of Defense (*DOD*) consultation letters which provide erroneous guidelines with respect to airborne radiation exposure during radiological emergency responses. The errors in these publications result from two sources: 1) incorrect determination of airborne activity, [1,2,3,4,5,6] and 2) incorrect guidelines on when respiratory protection is needed. [6,7,8] This paper will deal with the second of these two issues, determining when and what level of respiratory protection is needed.

When responding to a suspected radiological release, accurate data on airborne radiation levels may not be available and this could be due to time or equipment constraints. It is important to have appropriate methods to estimate the concentration of radionuclides in air, not only when air sampling equipment is available, but also when it is not. This paper will look at both of these situations. Methods using the primary instruments in the Army and Air Force inventory will be discussed.

Although it is certainly desirable to have response guidelines for all conceivable radiological events, this paper only outlines guidelines for potential releases of uranium and/or plutonium.

Methods

To determine respiratory protection requirements during a radiological event or emergency response, it is necessary to know the hazards associated with varying levels of airborne radiation, and know what levels available equipment are capable of adequately quantifying.

Terms Defined:

The Nuclear Regulatory Commission (*NRC*) is responsible for regulating the exposure of occupational workers to NRC-licensed radioactive materials. In this scope they have specified dose limits for internal and external exposures, for partial and whole body conditions. To understand these limits, several terms need to be defined.

1. Dose Equivalent (*H*)---The dose equivalent was developed to relate the relative risks of different types of radiation. Each type of radiation is assigned a quality factor (*Q*) (see Table 1) that reflects its associated potential to cause biological effects. The dose equivalent (*H*) is the absorbed dose (*D*) times the quality factor.

$$H = DQ$$

The quality factors currently used in the US were originally published in *ICRP* 26, [9] then later in *NCRP* 91 [10] (see Table 1. below).

2. Equivalent Dose (*H*)---Most countries, other than the United States, do not use dose equivalent in their radiation protection regulations, rather they use a similar term, equivalent dose (defined in ICRP 60). [12] The equivalent dose differs from dose equivalent in that it averages the dose over an entire organ, rather than looking at a

Table 1. Quality factors from ICRP 26 and NCRP 91.

Type of Radiation	Quality Factor
X-ray or gamma	1
Beta	1
Thermal neutrons	2
Neutrons of unknown energy*	10
High energy protons	10
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge	20

* Quality factors for neutrons of known energy are listed in the "Handbook of Health Physics and Radiological Health, Third Edition," Table 13.1.2. [11]

specific point in an organ, as does the dose equivalent. Additionally, the term quality factor is not used when determining equivalent dose, but a similar term called a weighting factor (W_R) is used. The ICRP 60 weighting factors differ somewhat from the ICRP 26 quality factors (see Table 2.).

Table 2. Weighting Factors (W_R) from ICRP 60.[13]

Type of Radiation	Quality Factor
Photons	1
Electrons and muons	1
Protons (other than recoil protons of energy > 2 MeV)	5
Neutrons	
< 10 *keV*	5
10 *keV* to 2 *MeV*	10
> 100 *keV* to 2 *MeV*	20
> 2 *MeV* to 20 *MeV*	10
> 20 *MeV*	5
Alpha particles, fission fragments, heavy nuclei	20

3. Committed dose Equivalent (CDE or $H_{50,T}$)---The dose equivalent delivered over a 50-year period to an organ or tissue as the result of an intake of radioactive material.

4. Committed effective dose equivalent (CEDE or $H_{50,E}$)---The sum of the CDE ($H_{50,E}$) for different organs or tissues in the body multiplied by appropriate weighting factors (W_T),

$$H_{50,E} = \sum \left(H_{50,T} W_T \right)_T$$

Table 3 lists the weighting factors currently used in the United States [13], whereas Table 4 lists those used by most other countries. [13]

Table 3. Organ Dose Weighting Factors (W_T)[a].

Organ or Tissue	WT
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surface	0.03
Remainder[b]	0.30

[a] 10 CFR 20.1003

[b] 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receive the highest doses.

5. Total Organ Dose Equivalent (TODE)---The sum of the Committed Dose Equivalent (CDE) and the dose equivalent from external exposure to the organ or tissue of interest,

TODE = CDE + external exposure

6. Total Effective Dose Equivalent (TEDE)---The sum of the dose equivalent from external exposure and the committed effective dose equivalent,

TEDE = CEDE + external exposure

Why do we need to understand these terms and definitions as used in other countries? First, our military forces are deployed to countries that use different standards. Also, since regulatory guidance changes over time, it is likely that the US will adopt the same international recommendations (*ICRP* 60) that are used throughout most of the world.

Dose Limits

The NRC has set maximum acceptable dose limits for occupationally-exposed adults to NRC-licensed materials. These same recommendations are made by the Environmental Protection Agency (EPA) and the Department of Energy (DOE), and are contained in Federal Guidance Report No.11 (FRG 11). [14] Occupational workers may receive a total organ dose equivalent (TODE) of up to 50 rem per year (0.5 Sv/year) from the intake of radioactive material.

External whole-body exposure is limited to 5 rem per year (NRC and DOE) or 1.25 rem per calendar quarter (OSHA) for occupationally exposed workers. These values are expressed as a Total Effective Dose Equivalent (TEDE) [15] which is the sum of all external sources of exposure as well as all internal sources which contribute to the total body exposure. In addition to these limits, all exposures must be kept as low as reasonably achievable (ALARA).

In emergency situations, the regulatory standards do not set a hard limit for the maximum exposures to response personnel. Based on which part of the law the personnel are working under, the Protective Action Guidance (PAG) for emergency personnel may have different recommended limits. Each PAG is listed based on the emergency actions required. These actions are (1) protecting major property (normally defined as property in excess of $100,000), (2) protecting large populations, and

(3) lifesaving. In general, DOE is more conservative in guidance than the NRC and EPA. In DOE guidance, population and lifesaving should not exceed 10 rem. NRC and EPA PAG guidance states a 25 rem limit. In both cases the maximum exposure may be exceeded based on the emergency situation at hand and must be voluntary. In all regulatory guidance, certain criteria must be met prior to allowing an exposure in excess of the 5 rem TEDE for emergency responders. When developing an emergency response plan for an organization, we recommend referencing ESH Document 22.6 Exposure to Radiation in an Emergency UCRL-MA-133867 dated SEP 2003,[16, 17] EPA Protective Actions For Nuclear Incidents # 400R92001 which superseded 520/1-75/001,[18] and NRC NUREG 0654; FEMA-REP-1 Criteria for Evaluation of Radiation Emergency Plans in Support of Nuclear Power Plants.[19] Tables 5 and 6 outline the basic emergency exposure criteria based on the above guidance.

In FRG 11, the Environmental Protection Agency (*EPA*) specifies maximum quantities of radionuclides that if ingested, or inhaled at the annual occupational exposure limit will result in these levels being reached.[20] These limits for inhalation and ingestion, which are also used by the NRC, are known as the Annual Limit on Intake (*ALI*). The calculations presented in this paper assume that responders will not ingest significant quantities of radionuclides during a response. Therefore, the only significant source of internal exposure to the radioisotopes will come from inhalation. The ALI for a radionuclide can vary from one chemical form of an isotope to another. For the specific cases of uranium and plutonium being addressed in this paper it is assumed that the radionuclides are present in chemically unreactive forms. This is the primary form responders will encounter during a response to a nuclear weapons accident, and most other types of emergency responses involving these isotopes.

In addition to the ALI, there is another term used by FGR 11 that needs to be defined. This term is the Derived Air Concentration (*DAC*). The *DAC* is the airborne concentration of a radionuclide that if someone inhales for 40 hours per week, for 50 weeks in a year would result in the

Table 4. Tissue Weighting Factors (W_T)[a].

Organ or Tissue	WT
Gonads	0.20
Red bone marrow	0.12
Colon	0.12
Lung	0.12
Stomach	0.12
Bladder	0.05
Breast	0.05
Liver	0.05
Esophagus	0.05
Thyroid	0.05
Skin	0.01
Bone surface	0.01
Remainder[b]	0.05

[a] ICRP 60
[b] Muscle, stomach wall, small intestine wall, lower large intestine wall, kidneys, pancreas, spleen, thymus, uterus, adrenals and bladder wall.

Table 5. Nuclear Regulatory Commission (NRC)/ Environmental Protection Agency (EPA) Guidance.

Dose Limit (rem)	Activity	Condition
5	All	
10	Protecting Valuable Property	Lower dose is not practicable
25	Life Saving or Protecting Large Populations	Lower dose is not practicable
> 25	Life Saving or Protecting Large Populations	Only voluntary basis to person who is fully aware of risks

Table 6. Department of Energy (DOE) Guidance.

Whole Body Dose (rem)	Activity	Condition*
<5	All	Any emergency
5-10	Lifesaving or Protection of large populations	Voluntary
> 10	Lifesaving or Protection of large populations	Voluntary

* Additional conditions apply of who may authorize these exposures and who must concur with that authorization.

ALI being obtained. In determining the *DAC* it is assumed that an occupational worker inhales 2400 m^3 of air per year, while at work. See Table 7 for a list of *DACs* for non-chemically active forms of Pu and U.

It is recommended that initial responders who are going to be exposed to greater than 1 *DAC* wear a full faced respirator, if one is available. Making the conservative assumption that a full faced respirator has a maximum protection factor of 100, [21] it is then recommended that initial responders exposed to greater than 100 *DAC* use a pressure demand Self Contained Breathing Apparatus (SCBA). Depending on response conditions health physicists or other professionals with experience in radiation protection may be able to recommend exposures to higher levels without respirators, or SCBA. This decision will be based on exposure times and the work being performed. The safety of personnel involved in the event and response must be the primary consideration. In order to keep exposures ALARA, it is important to consider what hazards are present, and how the use of personal protective equipment will affect the time personnel will be exposed to these hazards.

The numbers given in the previous paragraph are only recommendations. During an emergency response there may be no choice but to exceed these levels. In such cases it is important for first responders to know what levels they can be exposed to, without unacceptable risk to their lives or health. If *C* is the concentration of radionuclide in air, and the maximum exposure during an emergency response is 5 ALI, then the maximum time in minutes that a responder can be present in an area contaminated with Pu is:

$$t(Pu,\min)=\frac{.15}{C\left(\frac{MBq}{m^3}\right)}=\frac{5.6x10^{-3}}{C\left(\frac{\mu Ci}{m^3}\right)}$$

If uranium is the only contaminate of concern the equations become:

Table 7. Derived Air Concentration (*DAC*).

Isotopes*	***DAC (MBq/m³)***	***DAC (µCi/cm³)***	***DAC (dpm/m³)***
U-233	6 x 10^{-7}	2 x 10^{-11}	40
U-235	6 x 10^{-7}	2 x 10^{-11}	40
U-238	7 x 10^{-7}	2 x 10^{-11}	40
Pu-238	3 x 10^{-7}	8 x 10^{-12}	20
Pu-239	3 x 10^{-7}	7 x 10^{-12}	20
Pu-240	3 x 10^{-7}	7 x 10^{-12}	20
Pu-241	1 x 10^{-5}	3 x 10^{-12}	6

* Non-chemically reactive form of the isotopes. Taken from Federal Guidance Report No. 11 (1988). [15]

$$t(U,\min)=\frac{.30}{C\left(\frac{MBq}{m^3}\right)}=\frac{1.1x10^{-2}}{C\left(\frac{\mu Ci}{m^3}\right)}$$

If the possibility of Pu and U being present at the same time exists, as is the case in most weapons accident scenarios, the more conservative Pu equation should be used.

<u>Estimation of Airborne Radiation Levels</u>

During an emergency response air sampling equipment may not be available. It is important to have a method to estimate the concentration of radionuclide in air in this situation. The Nuclear Weapon Accident Response Procedures (*NARP*) recommends that alpha measurements be made on the ground and that these results be used to estimate the concentration of radionuclides in air [8]. If sufficient time has passed for smoke, and other airborne forms of the radionuclides to have settled, and no better method of estimating the airborne contamination levels exists, this should be done.

In this case, it is assumed that the only source of airborne contamination is from resuspension. The resuspension factor (R_f) is the ratio of the airborne concentration of a radionuclide to the surface contamination level.

Activity in Air (Ci/m^3) = Activity on Ground (Ci/m^2) x R_f (m^{-1})

The R_f value depends on many factors, including wind, soil movement in the area (e.g. vehicles moving in the area), surface properties (e.g. soil, asphalt, etc), particle size, etc. A conservative estimate for R_f of soil during a typical response scenario is 10^{-5} m^{-1}. Using these values, it is possible to determine surface contamination levels where respiratory protection is recommended, and maximum stay times in contaminated areas.

<u>Minimum detectable concentration</u>

After determining what levels of radiation exposure can be considered acceptable for first responders, the next step is to determine if available equipment is capable of discerning these levels from naturally-occurring background radiation. To do this, a value known as the Minimum Detectable Concentration (*MDC*) is determined. [22,23,24,25] The *MDC* is the net activity concentration above background that an instrument can be expected to detect. It is reported to a given confidence level, usually 2σ (95%).

The *MDC* can be defined as follows:

$$MDC=\frac{3+3.29\sqrt{R_b t_s\left(1+\frac{t_s}{t_b}\right)}}{Kt_s}$$

Where R_b is the average back-

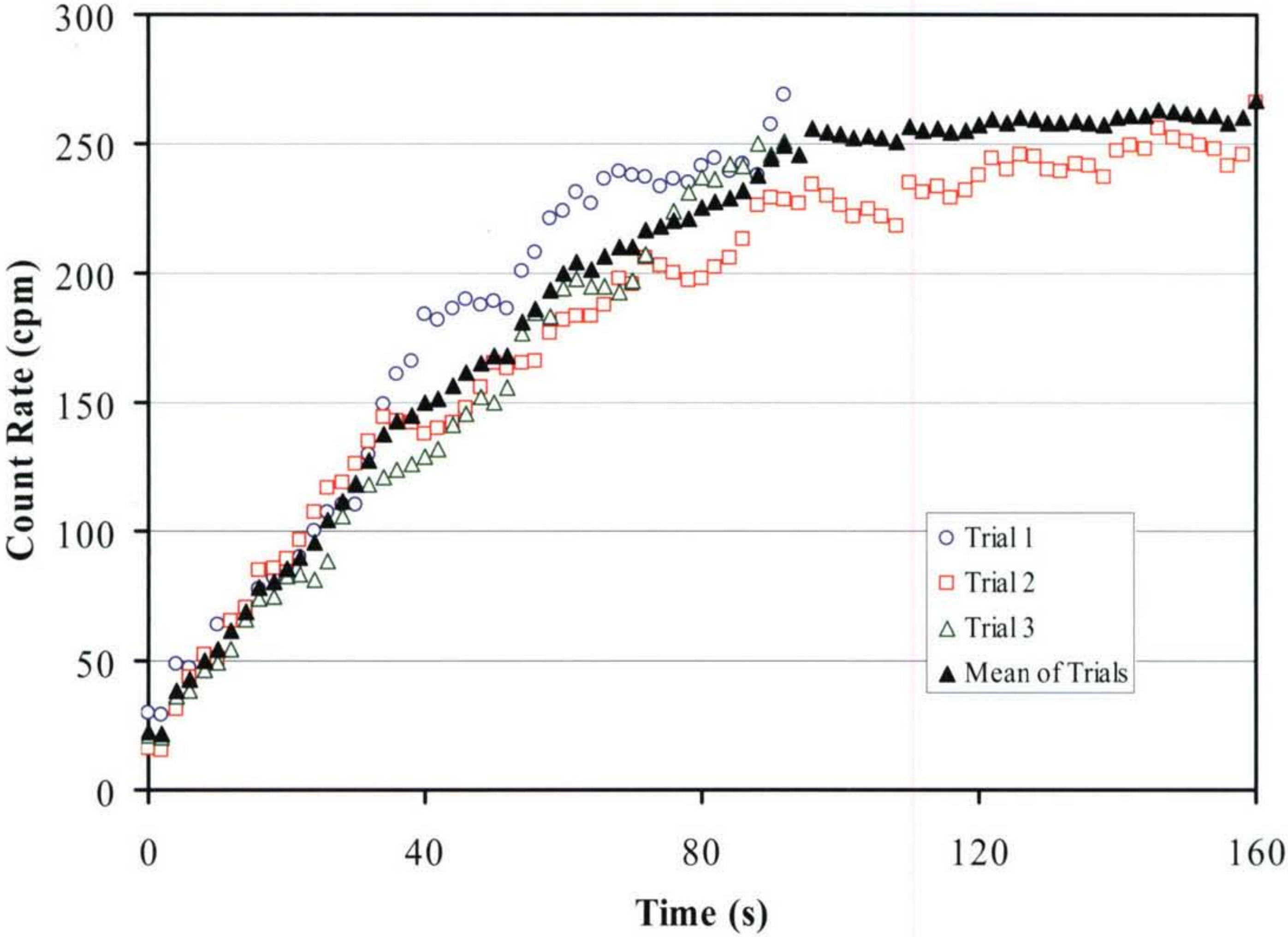

Figure 1. Displayed Count Rate as a function of time.

ground count rate taken over time t_b. t_b and t_s are the background and sample count times respectively. K is a proportionality constant that relates the detector response to the activity level in a sample. In the specific case of measuring contamination on a surface, K could be defined as the total detector efficiency (ε_T) in counts/disintegration times the physical probe area (A) in cm^2.

$$K = \varepsilon_T A$$

When the probe is used to measure radiological material collected on an air filter, the *MDC* of the air that was sampled can be calculated using the same equation as for surface contamination, however, in this case K becomes:

$$K = \varepsilon_T V k$$

where V is the volume of air sampled and k is a constant that converts time and distance to the desired units.

Ratemeter is a term that describes an instrument in which the number of interactions is integrated over a specified period of time. If a ratemeter is used, instead of a scalar to measure radiation levels, the equations change a little. [26] In this case the background and sample count times t_b and t_s are equal. As a result, the equation for the MDC simplifies to:

$$MDC = \frac{3 + 4.65\sqrt{C_b}}{Kt}$$

where C_b is the number of background counts measured in time t. For a ratemeter t can be considered to be approximately equal to 0.88 times the instrument response time (T_R , time interval required for the instrument reading to change from 10% to 90% of the final reading [or vice versa]). The *MDC* then becomes:

$$MDC = \frac{2.64 + 4.10\sqrt{C_b}}{KT_R}$$

Response times are usually determined by injecting a fixed pulse rate from a pulse generator.

A more accurate determination of the *MDC* can be made for a ratemeter if the instrument time constant (τ) is known. τ is the product of an in-

strument's resistance (R) and capacitance (C), RC. In this case, the *MDC* becomes:

$$MDC = \frac{2.12 + 3.29\sqrt{R_b \tau}}{K\tau}$$

Whereas the above methods for determining the MDC of a ratemeter work for most instruments, they are not sufficient for the ADM-300 and AN/PDR-77 used by the US military. With these instruments the instrument response time (T_R) and the "instrument time constant (τ)" are not constant. These instruments vary these "constants" through the use of a combined mathematical, electronic procedure. [27,28,29] Additionally the time over which measurements are averaged varies with these instruments. No one answer can be given as to how long these instruments should be held in one place before recording a measurement.

Figure 1 (previous page 18) shows the alpha count rate displayed by an ADM-300 attached to an AP-100 probe as a function of time post exposure to a radiation source. Four measurements were made with the same source and the same positioning of the probe. The time required for the instrument to display a count rate close to the true count rate varies with the activity of the source. As can be seen from this plot, at one minute the instrument was still underestimating the true count rate. τ for these measurements is estimated to be 47 seconds, based on the mean of the three trials.

Ratemeters, or instruments used in a rate mode are never preferred for estimating the concentration of radionuclides in air. This is, however, especially the case when dealing with the ADM-300 and the AN/PDR-77. These instruments should never be used in the rate mode when being used to estimate the concentration of radioactive material in air!

Table 8. *MDC* as a function of Count Rate and Matrix Transmission, determined by monitoring ground activity.

R_b (cpm)	*t(s)* *min*	*t(b)* *min*	ε_T*	*A* *cm²*	Matrix Transmission	Transmission Factor	*MDC* *dpm/m³*
1	1	1	0.15	123	1	1.00E-05	0.041
1	1	1	0.15	123	0.5	1.00E-05	0.083
1	1	1	0.15	123	0.25	1.00E-05	0.166
1	5	5	0.15	123	1	1.00E-05	0.015
1	5	5	0.15	123	0.5	1.00E-05	0.029
1	5	5	0.15	123	0.25	1.00E-05	0.058

*The 4π efficiency ε_T was obtained from the manufacturer. [31]

Table 9. MDC when using air monitoring equipment.

Rb (cpm)	*t(s)* *min*	*t(b)* *min*	ε_T	*V* *m³*	*MDC* *dpm/m³*
1	1	1	0.15	300	0.170
1	5	5	0.15	300	0.060

Table 10. Recommended Respiratory Protection Levels for emergency workers

Airborne Alpha Activity above background ***dpm/m³***	**Respiratory Protection**
< 18	No respiratory protection needed
< 1800	Full-face respiratory protection required
≥ 1800	Pressure demand SCBA

Results

As noted previously, two methods were described for estimating the concentrations of radionuclides in air. First is the case of indirect assessment of airborne radionuclides based on ground contamination levels when air sampling equipment is not available. The second case is for direct assessment with air monitoring equipment.

First, for indirect assessment using scalar mode, if the background count rate is assumed to be 1.00 (NUREG 1507 Table 5.1), [30] the matrix transmission is assumed to be 100% (no self-absorption of alphas particles by soil), and a one minute count time is used; then the *MDC* for the ADM-300 with an attached AP-100 or the PD-77 with a DT-669/PDR-77 probe, is calculated to be 41 *dpm/100cm²*. For a more realistic transmission factor of 50%, the *MDC* increases to 83*dpm/100cm²*. By increasing the count time to 5 minutes, these values can be decreased to 15 *dpm/100cm²* and 29 *dpm/100cm²* respectively (see Table 8.).

In the case of direct assessment, using a minimum of 1000 *ft³* of sampled air volume, [32] the *MDC* is 0.17 *dpm/m³* for 1 minute count times, and .060 for 5 minute count times (see Table 9.).

From the discussion and *DACs* presented in the previous section, it can be concluded that below 18 *dpm/m³* plutonium, or 36 *dpm/m³* uranium, it is safe to enter an area without respiratory protection.

Table 10 gives recommended respiratory protection for emergency response to radiological incidents involving uranium and/or plutonium. It

Table 11. Recommended Respiratory Protection Levels for Emergency Workers as a Function of Surface Contamination.

Surface Alpha Activity above background			**Respiratory Protection**
CPM*	***MBq/m²***	***µCi/m²***	
< 1600	< 0.03	< 0.81	No respiratory protection required
1600 to 160,000	0.03 to 3	0.81 to 81	Full-face respiratory protection required
> 160,000	> 3	> 81	Pressure demand SCBA

- *CPM* was calculated using conversion factors determined for ADM-300 with an AP-100 by Canberra Dover, Inc. The conversion factors can be determined from Table AP13.T5 in Appendix 13 of the *NARP*. The conversion assumes that the measurements are being made in soil. Appropriate conversion factors for Concrete, wood and stainless steel can be obtained from Table AP13.T.5.
- Assumes a 4π efficiency in soil of 7.2%. This is an instrument efficiency of 15% times a transmittance of 50%, with the result rounded down (conservative approximation) to 2 significant figures.
- A resuspension rate of 1 x 10^{-5} m^{-1} was used in these calculations.

should be noted that these recommendations are significantly different than those published in the Nuclear Weapon Accident Response Procedures (*NARP* Appendix 11, see Tables AP11.T1, AP11.T2, and AP11.T3). [8]

If the time or equipment needed to measure airborne radiation levels is not available, respiratory protection recommendations may be made based on ground alpha levels. To accurately convert between *µCi/m²* and *CPM* it is necessary to know the instrument efficiency under the conditions the instrument is being used. The efficiency is dependant upon the instrument and the type of surface being measured. The manufacturer of the ADM-300/AP-100 and the DT-669/PDR-77 has determined the instrument *4π* efficiencies to be 15%

when there is 100% transmittance of the radionuclide to the surface. In soil this is clearly not the case. The authors have assumed a 50% transmittance to the surface in determining the *CPM* column of Table 11. This yields a resulting efficiency of 7.5%. Accurate determination of this value can only be determined through carefully performed laboratory experiments. It should be noted that the 7.5% efficiency is considerably less than that published in Appendix 13 of the Nuclear Weapon Accident Response Procedures (*NARP*). [33] The values in the *NARP* for the ADM-300 assumed an efficiency in soil of 12.2% (transmittance of alphas in soil of 81%). The authors believe the soil efficiency used in the calculations presented in the *NARP* is high. Seven-an-a-half (7.5) is a more reasonable value, and represents a more conservative approach. As more accurate measurements of the efficiency of this probe in soil become available, the values in Table 11 should be adjusted to reflect these values.

Noted that ground measurements should only be used to determine respiratory protection recommendations if other more accurate methods are not available. These values can only be trusted if sufficient time has passed for the particles released during the incident to have settled. In most accident scenarios involving uranium and/or plutonium, this is expected to occur in less than 1 hour from the end of the release.

Conclusions

It is recommended that initial responders exposed to greater than 1 *DAC* of radiation use, as a minimum, a full faced respirator. Anyone exposed to greater than 100 *DAC* should use SCBA. Depending on response times and conditions a health physicist or other professional trained in radiation protection may be able to recommend higher levels for a specific response. *DACs* for uranium and plutonium are listed in Table 7. Recommended levels of respiratory protection as a function of air concen-

tration are listed in Table 10.

Air sampling and alpha monitoring equipment typically found in Army and Air Force inventories are capable of seeing these levels of airborne radioactivity.

If air sampling material is not available, or if time constraints do not permit their use, acceptable levels of respiratory protection can be estimated using ground monitoring equipment and previously determined resuspension factors (see Table 11). This method should only be used if more accurate methods are not available and sufficient time has passed since the release that resuspension is the only significant source of radioactivity in air. This is typically the case an hour or more post release.

During an emergency response it may be necessary for rescue personnel to enter an area without the recommended level of respiratory protection. In such cases the following times should be considered maximum stay times for personnel involved in lifesaving activities.

When Pu, or Pu and U are present:

$$t(Pu,\min) = \frac{.15}{C\left(\frac{MBq}{m^3}\right)} = \frac{5.6x10^{-3}}{C\left(\frac{\mu Ci}{m^3}\right)}$$

When only U is present:

$$t(U,\min) = \frac{.30}{C\left(\frac{MBq}{m^3}\right)} = \frac{1.1x10^{-2}}{C\left(\frac{\mu Ci}{m^3}\right)}$$

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The Army Organizes for Combating Weapons of Mass Destruction

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Combating Weapons of Mass Destruction and Proliferation Policy Division, Capabilities Based Assessments (CBAs), Combating Weapons of Mass Destruction Joint Integrating Concept (JIC), Joint Coordination Element for Elimination (JEC-E), Joint Capabilities Integration Development System (JCIDS), DOTMLPF Change Recommendation (DCR), Force Design Update (FDU), WMD-Elimination (WMD-E), WMD CONOPS ---These terms, now emblematic of the common combating weapons of mass destruction (CWMD) lexicon, are but a small sample of the many concepts, issues, and areas of concern facing the Army's CWMD community. The requirement to repeatedly address these or similarly important topics triggered an important question often asked by organizations internal and external to the Army. *"Who is the Army's lead for CWMD?"*

Prior to 1 October 2005, the response to that question was unclear and ambiguous. There were many disparate organizations working diligently to address Army CWMD issues, but their work was executed in stove-piped fashion and their efforts were often redundant, counterproductive, or not executed by the appropriate Army organization. The requirement for a definitive answer to the question was underscored by the dramatic increase in CWMD OPTEMPO following September 11, 2001, the subsequent Global War on Terrorism, and publication of the *National Strategy to Combat Weapons of Mass Destruction* (December 2002).

Since that time, CWMD has become a primary area of concern in several overarching military strategic documents. One of the six Military Strategic Objectives cited in the *National Strategic Plan for the War on Terrorism (NMS-WOT)* dated 1 February 2006 addresses WMD; the 9 February 2006 *National Military Strategy to Combat Weapons of Mass Destruction (NMS-CWMD)* presents comprehensive guidance and a framework that provides the Department of Defense (DOD) with a construct for deliberate planning, operations and capabilities development. Additionally, the 2006 Quadrennial Defense Review (QDR) identified CWMD as one of four focus areas to be considered during the QDR assessment of the National Defense Strategy (published March 2005) and review of the DoD force planning construct. However, Headquarters, Department of the Army (HQDA) was not organized to meet the challenges of unconventional and asymmetrical warfare, nor did it have the ability to provide sustained and holistic oversight of development of Army policy to combat WMD.

The purpose of this article is to highlight the Army Staff's (ARSTAF) organization and approach to meet Army CWMD challenges and establishment of an Army lead agent for CWMD.

Addressing the Need

Between the events ensuing from attacks upon the United States on September 11, 2001 and the guidance set forth by the QDR in February 2006, a series of events within the National Security arena emphasized the requirement for an Army focal point for CWMD. National Security policy documents identified WMD in the possession of terrorists and potential adversaries as our nation's greatest security threat. In January 2005, the Secretary of Defense (SecDef) designated US Strategic Command (USSTRATCOM) as the lead combatant command within DOD for synchronizing and integrating CWMD efforts. This directive was codified in the May 2006 Unified Command Plan. Concomitant with the January 2005 SecDef directive, USSTRATCOM was directed to use its Army Component (ARSTRAT) to lead the inter-service effort in coordinating the development of WMD elimination capabilities. The Office of the Secretary of Defense (OSD) and the Joint community worked diligently to develop the NMS-CWMD. In his endorsement of the NMS-CWMD, the Chairman of the Joint Chiefs of Staff, General Peter Pace, stated that *"We must possess the full range of operational capabilities to protect the United States, US military forces, and partners and allies from the threat or actual use of WMD."* [1]

Careful assessment of the Army's approach to addressing CWMD capability requirements revealed that HQDA was not effectively organized to meet the challenges posed by the use and effects of use of WMD. The Army's National Security Policy Division, within the Office of the Deputy Chief of Staff (DCS), G-3/5/7, was the office responsible for the development of Army CWMD policy, but was little known across the Army and

lacked sufficient personnel dedicated to the development and execution of Army CWMD policy. In recognition of this major shortfall, the DCS, G-3/5/7 reorganized the National Security Policy Division, renamed it the Combating Weapons of Mass Destruction and Proliferation Policy Division (G35-SSD), and refined its mission to *"develop Army Combating WMD and proliferation policies consistent with national strategy to provide trained and ready forces capable of supporting combating WMD missions."* [2]

The intent of the reorganization was not to replace existing organizations that addressed chemical, biological, radiological, or nuclear (CBRN) concerns, but rather to be the office responsible for the development of Army CWMD policies consistent with national and military strategies. G35-SSD is the Army's focal point for CWMD and ensures coordination across the ARSTAF, Army Service Component Commands (ASCCs), Direct Reporting Units (DRUs) and Army Commands (ACOMs) on key Doctrine, Organization, Training, Materiel, Logistics, Personnel, and Facilities (DOTMLPF) concerns. The Division synchronizes Army CWMD efforts within HQDA to improve Army capabilities across the eight CWMD mission areas (security cooperation, threat reduction, offensive operations, active defense, passive defense, interdiction, elimination, and consequence management). Having an office of primary responsibility for development of Army CWMD allows for better articulation of Army positions to OSD and Joint Staff organizations, as well as support to the senior Army leadership concerning the full spectrum of CWMD, conventional weapons proliferation, and other emerging CBRN matters.

The organizational framework mirrors the pillar alignment outlined in the national and military CWMD strategies (Figure 1). It consists of Nonproliferation (NP), Counterproliferation (CP), and Consequence Management (CM) branches. A fourth branch - Integration and Analysis - ensures Army CWMD activities are synchronized with OSD and Joint Staff activities, provides analysis of

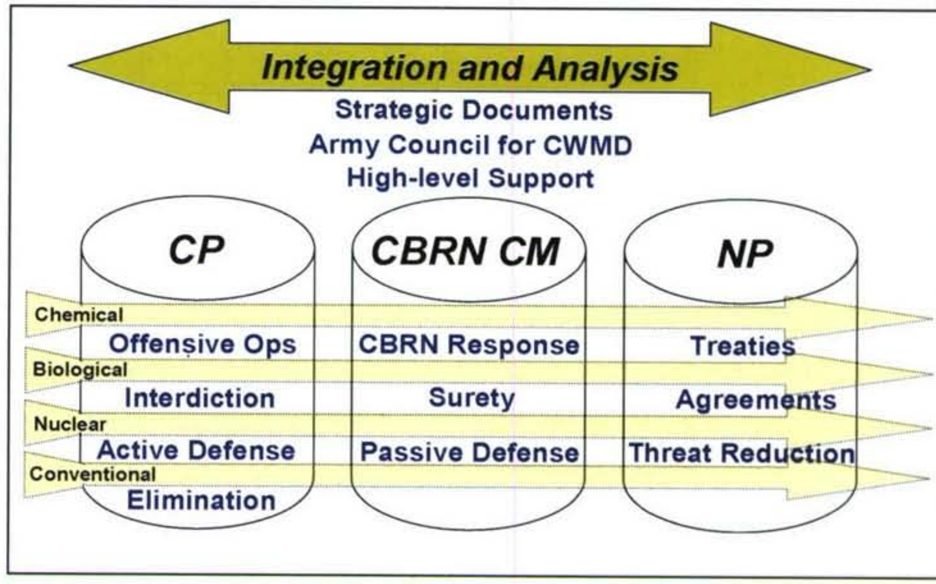

Figure 1. Combating WMD and Proliferation Policy Division.

overarching CWMD documents, and serves as the Executive Secretary for the Army Council for Combating Weapons of Mass Destruction.

Although the reorganization of G35-SSD improved the Army's ability to develop and oversee Army CWMD strategy and policy, a gap remained between policy development and policy execution. To fill this void, the US Army Nuclear and CWMD Agency (USANCA), formerly a Training and Doctrine Command (TRADOC) element, was transferred to the Office of the DCS, G-3/5/7 in April 2006 and is undergoing transformation to become the US Army Nuclear and CWMD Agency. USANCA now performs functions as a Field Operating Agency (FOA) for G-3/5/7. The stand-up of the FOA will assist the Army in addressing shortfalls in CWMD policy implementation.

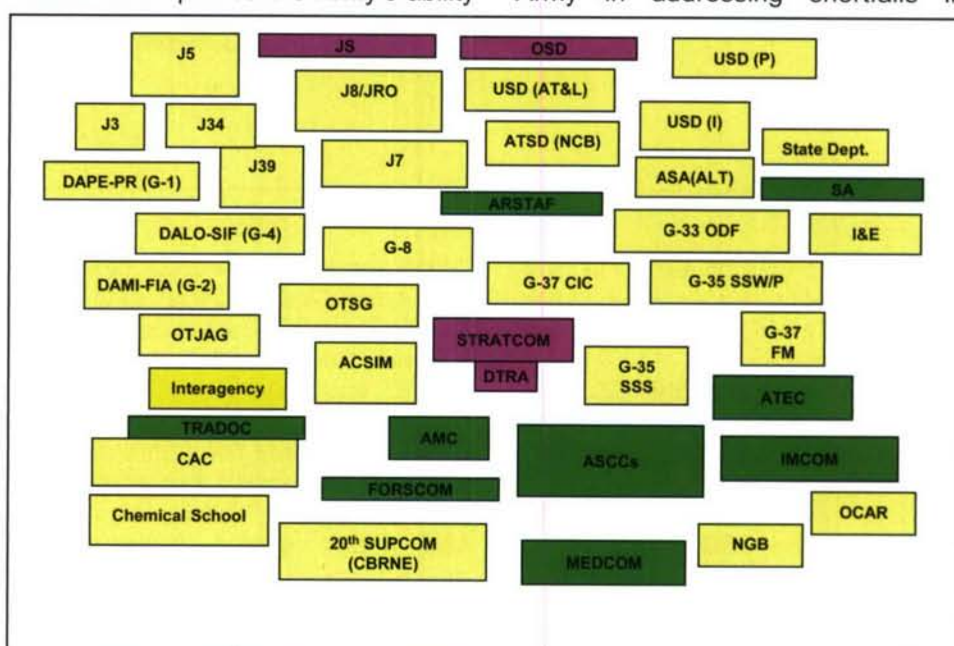

Figure 2. CWMD Coordination Network.

Together G35-SSD and USANCA provide key linkages across the CWMD community within DOD. Figure 2 is a representation of the broad CWMD network requiring interface and coordination. It shows the breadth and depth of OSD, Joint, and

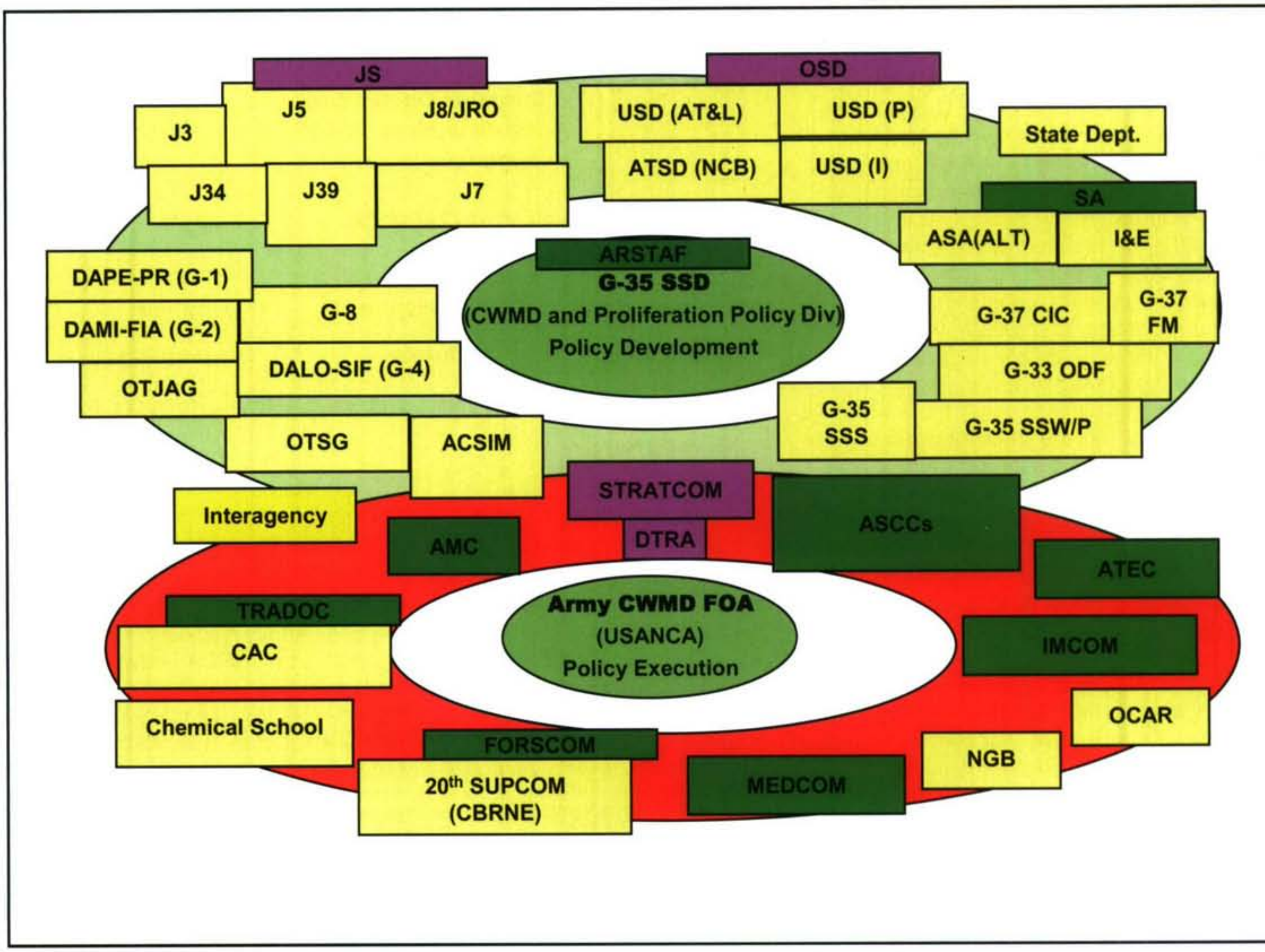

Figure 3. G35-SSD CWMD Coordination Approach

Army entities that influence the overall CWMD effort across the full spectrum of DOTMLPF.

Figure 3 portrays the G35-SSD approach. The "green donut" represents the G35-SSD focus within the ARSTAF to provide interface and coordination within the CWMD community, as well as OSD and Joint entities, while the "red donut" represents the FOA's focus across ASCCs, DRUs, and ACOMs. This approach provides not only linkages between ARSTAF policy development and execution, but also addresses the gap discussed earlier.

To assist in the orchestration of Army CWMD efforts, the Army established the Army Council for Combating WMD (ACCWMD). The ACCWMD, chaired by Office of the Director, Strategy, Plans and Policy (G-35), provides Colonel and General Officer forums that address crosscutting Army CWMD issues and concerns. The ACCWMD provides: integration and synchronization of CWMD issues across DOTMLPF; a mechanism for identifying Army CWMD capability requirements; and a means for moving key issues forward to the Army leadership for resolution and/or decision. It also serves as a conduit to CWMD organizations within OSD, the Joint Staff, ASCCs, DRUs and ACOMs.

Improvements in CWMD Activities

Reorganization for CWMD has improved Army coverage and influence within the respective pillar areas. The following summary highlights Army activities and initiatives:

Nonproliferation: The Army adheres to national implementation and compliance initiatives for cooperative threat reduction, treaties, agreements, export controls and international programs aimed at preventing, dissuading, and denying access to WMD capabilities. To support these initiatives, the Army is working to achieve two nationally directed goals. First, the Army is helping to shape the future security environment as directed by the 2006 Quadrennial Defense Review (QDR) and National Defense Strategy. On every level, the Army is transforming and shifting from a reactive posture and becoming more proactive in its efforts to implement timely and preventive measures to preclude the need for crisis intervention and response relating to WMD. Second, the Army is fostering an atmosphere for expanding foreign partnerships and building partnership capacity, an established goal of the NMS-CWMD, and a crosscutting enabler to win the Global War on Terrorism. Army cooperation in export controls and meeting its international

treaty obligations contribute to this effort.

Counterproliferation: The Army assessed its capabilities and capacity to conduct WMD-Elimination operations with an Operational and Organizational and Force Design update for the 20th Support Command (CBRNE).

Enhancements to the 20th Support Command (CBRNE) will ensure the Army will be able to fulfill a QDR tasking to expand its capabilities, by 2007, to serve as the core element of a Joint Task Force capable of rapid deployment to command and control WMD elimination and site exploitation missions. The Army is the Executive Secretary for the Chemical and Biological Defense Program – providing a strategic 'roadmap' for providing critical chemical and biological protection and defense for the men and women of the Armed Forces.

Consequence Management: The Army is supporting efforts to provide consequence management capabilities that support both homeland defense from WMD attacks in domestic consequence management (DCM) and assists friends and allies in foreign consequence management (FCM). The Army remains focused on protecting its forces with passive defense measures and enabling them to mitigate the effects of WMD use in combat operations (Combat CM), to include WMD-Elimination operations. These efforts include working with the National Guard in developing unique capabilities such as the CBRN Emergency Response Force Packages (CERFP) for DCM, developing capabilities in Hazardous Response and Decontamination (HRD) for Army Chemical decontamination platoons that can be applied to DCM, FCM, and Combat CM. The Army is integrating CBRN consequence management into various Army efforts such as Multi-Service Force Development – Steady State Security Posture review and the WMD Consequence Management Capabilities Based Assessment. The Army is also engaged in protecting installations through the Installation Protection Program (IPP) in both CONUS and OCONUS Army Installations. The activation of Headquarters, US Army North (ARNORTH), US Northern Command, provides an Army headquarters capable of supporting a range of homeland defense operations and disaster assistance, including DCM. ARNORTH reached full operational capability in September 2006.

In addition to improvements within the pillar areas, the Army supports and has implemented other CWMD policies and initiatives. In an effort to improve and employ critical CWMD capabilities, G-35, through revision of Army Regulation 5-22 (The Army Proponent System) recommended respective proponents per priority CWMD mission area – WMD-Elimination, CBRN Offensive Operations, CBRN Passive Defense and CBRN Consequence Management. Assignment of proponents provides oversight to mission areas with capability or resource shortfalls, optimizes extant Army CWMD-related capabilities to ensure readiness for these priority missions, and efficiently allocates finite resources. The Army continues to operationalize its role in WMD- Elimination operations, and is developing solutions to improve Army contributions to Homeland Defense as it relates to CBRN consequence management.

The Future for Army CWMD

The ARSTAF will continue using its new organizational construct to assess its ability to address CWMD issues across the spectrum of DOTMLPF and improve its CWMD capabilities and capacity. Synchronizing and integrating Army CWMD activities allows the Army to speak with one voice, protect Army interests, reduce inefficiencies, link existing capacities, and exploit potential capabilities by engaging key stakeholders across the Army.

A major activity planned for 2007 is the second annual Army CWMD Conference. The first Army CWMD Conference, held in May 2006, gathered OSD, Joint Staff, Sister Services, DTRA, Combatant Commands, and other pertinent government agencies together to exchange ideas on CWMD and to establish relationships to facilitate cooperative efforts throughout DOD. A major goal of the 2007 conference is to provide an interactive forum to identify and recommend solutions to key CWMD issues affecting ASCCs and examine the Army's ability to support Combatant Command plans relating to CWMD.

Conclusion

The Army is a key player in the Global War on Terrorism and response to unconventional and asymmetric threats like those posed by proliferation and use of WMD. The Army provides unique expertise and capabilities across the CWMD mission areas - particularly in CBRN Offensive Operations, WMD-Elimination, Passive Defense and CBRN CM. DOD and the nation rely on the Army to provide a fully capable, organized, trained and equipped force with the capabilities to deny, destroy, or respond to and mitigate the effects of WMD. The organizational efforts outlined herein allows for improved interface across multiple levels of the Army and DOD, and postures the Army to formulate coherent Army CWMD strategies and policies, articulated within the components of The Army Plan. These will in turn generate the capability requirements essential to CWMD across the DOTMLPF spectrum and the eight CWMD mission areas.

Ms. Janet Strafer is a Headquarters, Department of the Army Civilian and Chief, Integration and Analysis Branch of the Combating Weapons of Mass Destruction and Proliferation Policy Division within the Office of the Deputy Chief of Staff, G-3/5/7. Ms. Strafer has B.A. and M.A. Degrees in Education from the College of William and Mary and is a graduate of the Army Management Staff College and US Army War College.

ENDNOTES:

[1] Chairman of the Joint Chiefs of Staff Memorandum, CM-0194-06, 13 February 2006, National Military Strategy to Combat Weapons of Mass Destruction.

[2] Combating Weapons of Mass Destruction and Proliferation Policy Decision Briefing to DCS, G-3/5/7, 1 September 2005.

Sticks and Stones May Break My Bones, but TICs Will Never Hurt Me?

Mr. Gwyn Winfield

NBC International Looks at the Military Obsession With Toxic Industrial Chemicals

The threat from toxic industrial chemical/material (TIC/TIM) facing military forces on deployed operations is undoubted: there is a lot of it around; in fact, there is an awful lot of it around. Whether it is hydrogen fluoride in petro-chemical plants or ammonia in milk processing plants, there is no shortage of TICs in the urban environment. Neither is there a shortage of desire to use them. US troops in Fallujah found a paint sprayer and chemicals that insurgents wanted to mix together as a weapon against coalition troops. These two factors have spawned a whole threat cottage industry in the military, with policy people dreaming up doomsday scenarios and procurement individuals rapidly backfilling the capability gap.

While over-match is a military doctrine to be warmly embraced, in my opinion it is not justified by the threat. Any individual sitting down with the Bumper Book of Organic Chemistry can come up with an Armageddon agent. There are tens of thousands of toxic industrial materials (water, for example, can be classed as a TIM since you can't breathe in H_2O) and it seems to be a military parlour game to come up with one that no-one else has heard of and tell you how little it takes to kill you. Yet a lot of this is down to faulty risk assessment, or rather accurate risk assessment not being filtered down. Everyone knows what the worst chemicals are, the ones that can survive being explosively disseminated, that don't disperse or get burned off too quickly, that can affect individuals with a minimum dose (either dermal or respiratory), that are odourless and colourless, etc. How do we know? Well, we spent million of dollars, pounds and roubles on them and we call them chemical warfare agents. Those chemicals that didn't fit the bill were never weaponised for good reasons because they would not fit into one of those categories.

Despite this it is the quantity of agent that fixates the military. The most popular scenario is that a terrorist could take a truckload of ammonia/chlorine/methyl-ethyl-dead-by-noon, drive it up to a base and explode it. This is undoubtedly true, but equally a terrorist could fill a van with chemical explosive, drive it up to the base and explode it. The death toll from the latter would be far more likely to outweigh the former. Equally, our friend in Fallujah who created his home-grown chemical sprayer could have easily decided to create a home-grown flame thrower – equally difficult to defend against (in fact you could argue more difficult as the user doesn't give the game away by having to use it in PPE). Yet you don't see theoreticians and procurement wonks beset by the flame-thrower problem in the same way as TICs.

The solution to the TICs problem seems to be to deploy detectors down the food chain to proliferate the battlefield with detectors. But TICs detectors are not the same as IMS CWA detectors. They have a higher training burden (and if they are GCMS then they have an high training burden), a high price ticket and require regular calibration and maintenance programmes . Sebastian Meyer Plath of Bruker Daltonics pointed out that it was even more complicated than that. "The whole thing needs to be thought through and to a certain extent you can come out with an application that is more useful to a fire brigade or first responder. You, as a military user, will have an instrument which will detect 50,000 TICs. So when you get an alarm, that doesn't help you at all. You don't know what to do next because you might not have encountered that chemical before. You need a direct link to a database in a system that tells you what to do now, how to behave and what not to do. In all the military requirements that I have seen in the past that this is not part of it."

Chris Wrenn, Senior Director of Sales for RAE Systems, agreed that proliferation down to the lowest level was not the wisest option. "What RAE Systems have been successful in doing is fielding products to be a more sophisticated subset of the military. The tricorder in Star Trek was never given to the idiot; it was always given to the smartest guy. Detectors need detectives behind them; it all comes down to training. One problem is that you [as a soldier] are trained to be a general officer, not an expert on anything and once you get trained up to something you then move on. Historically, being a chemical officer used to be looked upon as a dead-end job and didn't attract the best."

The previous way of dealing with TICs was through mass spectrometry (MS). MS used to be so large that it needed a substantial vehicle to deliver it, such as a Fox/Fuchs or VAB Reco. With Inficon's Hapsite, mass spectrometry suddenly became mobile and proliferated without a great deal of thought of what was next. Carrier gases, calibration and training seemed small issues compared to being able to defeat the TICs threat. "The biggest thing that holds back the MultiRAE in the military," said Chris Wrenn, "is the logistics of calibration. The military wants products that can just sit on the shelf for years and then be picked up and used. If you take a gas monitor off the shelf and it has been there 20 months it is most likely

that a lot of it won't work," he continued.

Now that first flush of innocence is over, it would make sense for TICs detection to go back to being vehicle borne. This puts it back in the hands of specialists and people who know what the sensor is doing. One of the disadvantages of taking IMS detectors down to the front line is that it erodes common sense. Soldiers believe technology when it says there is an alarm and when everything around them is clearly shrieking that it was a false alarm. CWA IMS have a small window of agents, meaning that their window of false alarms is also small. With a TICs detector that can analyse over 50,000 chemicals the system may either be alarming all the time (because the PPM is set too low) or because the chemical signatures of the benign agents are close to the malign ones. All operational tempo goes out the window until chemical officers turn up to turn the common sense on. "You could make mass spec even smaller than Hapsite or MM2, but MS will always be an expensive piece of kit, coming in at about $90,000. The question is why would you want to take this expensive piece of equipment into the contamination when you could keep it outside the contamination and bring the minute sample to the MS. If that is true keep it simple, don't miniaturise MS further, leave it with a high-spec technical capability which is directly correlated with its size – due to the laws of physics – and keep it outside the contamination."

MS is certainly the gold standard of TICs detection and is better left with the experts, but there surely should be a silver standard, something that provides 80 percent of the capability but without the training burden and cost. Sebastian Meyer Plath doubted it but suggested it depended on your time scale. "It is hard to say, it depends on the horizon that you are looking at. With regard to the number of compounds that you are able to detect at one time MS will always be much more powerful than anything else. I don't see anything that can compete with MS, it is not IMS and you can build up huge arrays of electro-chemical cells, for example, but that is going to be complicated and expensive as well."

Chris Wrenn suggested that some IMS did have a place in TICs detection, like Environics Chempro 100, but that the best way to deal with the TICs threat was to network arrays of sensors rather than relying on a detector or needing to bring the MS to the contamination. "It comes down to best protection being the pervasiveness of the sensing technology. In the TIC world the question is how many sensors do they need? If you can propagate as many reliable TIC sensors as you can, then you get a reliable picture of what is going on."

The furore around TICs will die down soon and they can take their place in the threat spectrum rather than being the latest way of furthering people's careers ("I solved the deadly TICs problem"). There also needs to be an accepted list of TICs agents that the military can agree on. This happened in 1998 and accepted as ITF-25 by the British, Canadians and Americans, yet does not seem to have achieved ubiquity despite bearing a resemblance to other lists such as the US National Institute of Justice's list. Once an agreed list can be provided, a silver or even bronze standard of detection – that just detects those agents – can be engineered and deploying a TICs capability down to the front line will follow. Hopefully ITF-25 can be further embraced in the military and we can be free from the fear of osmium tetroxide and other chemicals dug out of the organic chemistry mine.

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U.S. Army 20th Support Command (CBRNE) Organization/Transformation

Prepared by the Public Affairs staff at the 20th Support Command (CBRNE)

As the Army transforms to meet current and future requirements, it is being driven by the need to build adaptive, flexible capabilities to deal with a wide range of threats and adversaries. Over the past 10 years, there has been a dramatic increase in disruptive, irregular, complex and improvised threats. This shift in paradigm, from traditional threats with organized formations to an adaptively networked asymmetric environment, requires a comprehensive transformation of all of key capabilities and enablers which mitigate these current and emerging challenges. As the Army has transformed its Brigade Combat Teams, and all the supporting functional enablers, a parallel transformation effort is also underway spearheaded by the 20th Support Command (Chemical, Biological, Radiological, Nuclear, and High-Yield Explosives). This parallel transformation will increase command and control while providing multi-disciplined CBRNE and combating WMD capabilities to the Army. These changes will better focus efforts and resources towards combating weapons of mass destruction while adding new capabilities to meet new requirements. This effort is in concert with a wide range of specialized CBRNE and Combating WMD capabilities within the Joint Force. This model builds on the concept of joint interdependency, leveraging the best capabilities available in order to provide responsive, ready forces to Combatant Commanders.

In the 2006 Quadrennial Defense Review, the Army was directed to: "Expand the Army's 20th Support Command (CBRNE) capabilities to enable it to serve as a Joint Task Force capable of rapid deployment to command and control WMD elimination and site exploitation missions by 2007."

Leveraging a wide range of Army, Joint, DOD, and interagency efforts, the 20th Support Command (CBRNE) quickly developed a transformation strategy that will deliver an Initial Operational Capability (IOC) in 2007. This strategy will provide a JTF for WMD-E capability and equally important, it will designate a single Command assigned all of FORSCOM's active component CBRNE capabilities packaged into cohesive, modular, and expeditionary formations. The power of this new HQ C2 element and integration of forces is extraordinary. It provides Army Commanders, Joint Commanders and Lead Federal Agencies a full spectrum, expeditionary CBRNE capability, with the capacity to execute simultaneous OCONUS and CONUS missions for CBRNE/WMD Elimination missions. Once Final Operational Capability (FOC) is complete, this Command will be rapidly deployable, equipped with rugged and specialized equipment, and built to support all of the standing and emerging CONOPs. The documentation authorizing the new manpower and equipment for these expanded capabilities has already been approved, and the Command is expected to reach IOC by October 2007, in line with the QDR. FOC will be reached in three phases, culminating in October 2009.

To meet the QDR requirements, the 20th Support Command (CBRNE) is undergoing a major reorganization. It is taking a response-focused, non-deployable HQ and turning it into a HQ able to quickly deploy and operate effectively in joint, combined, and interagency operations. This transformation also builds a unit that is able to deploy in support of major contingency operations, while still maintaining a ready state to support first responders and homeland defense throughout CONUS.

Key elements in the HQ include both an Operational Command Post (OCP) and a Main Command Post (MCP). The OCP will deploy forward to command and control specialized CBRNE capabilities assets, both from within and outside the command. By design, the OCP can serve as a Joint Task Force headquarters for WMD Elimination, support a larger Combined Joint Task Force, or provide direct support to the Combatant Commander. Meanwhile, the MCP remains in place providing 24/7 real-time reach-back support, connectivity with lab and scientific assets, and C2 of CONUS-based forces. The MCP stays in the rear managing the many homeland defense and other peacetime commitments, preparing the rest of the Command for future missions, and providing support to the deployed forces.

The 20th will provide specialized CBRNE response forces and elements to support both the homeland and overseas contingencies. The organization will leverage sanctuary reach back in order to link subject matter experts in America's defense,

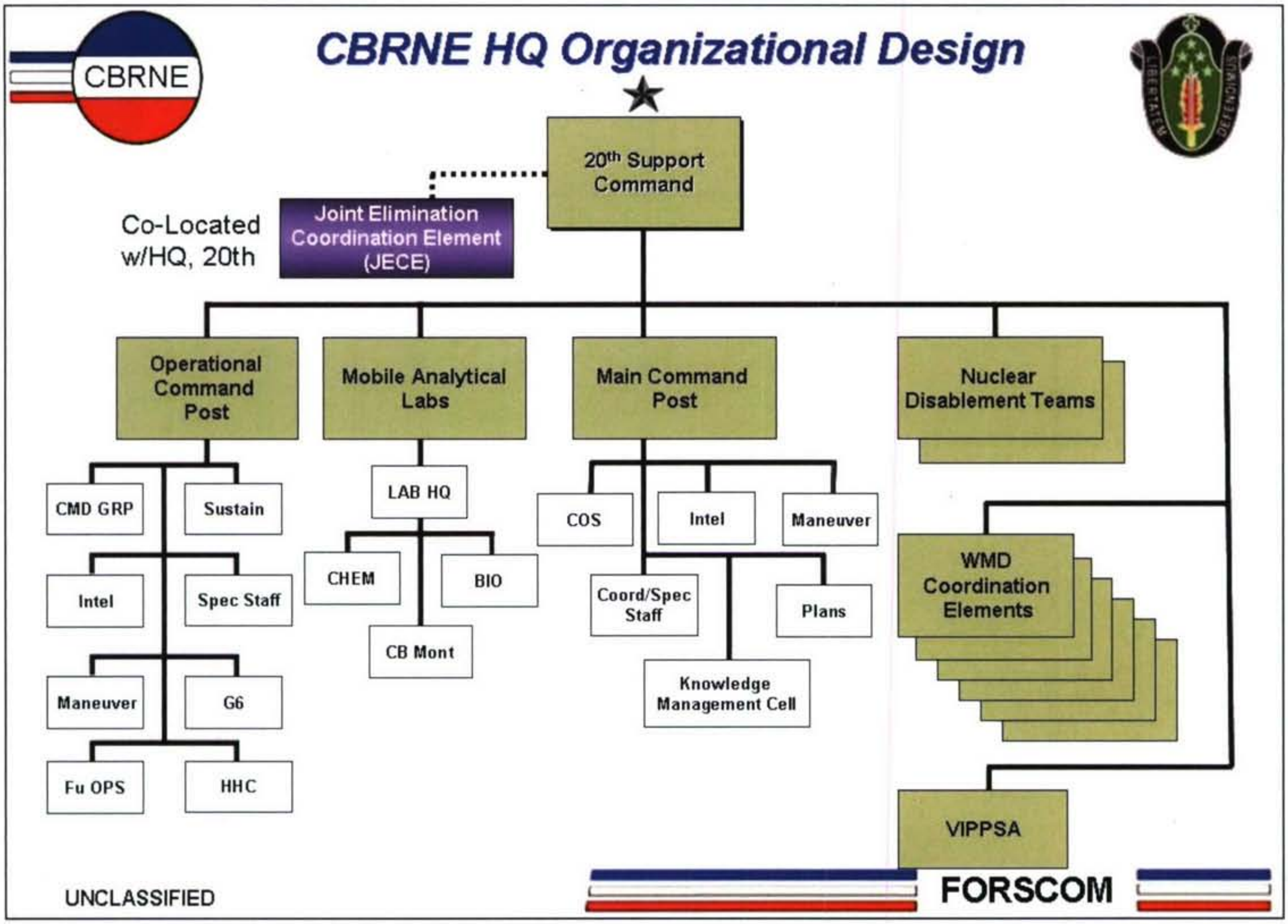


Figure 1. Staff Organization Chart.

scientific and technological communities with deployed elements and possibly first responders. See Figure 1. Staff Organization Chart.

"In addition to the typical Army staff found at an organization like ours, our headquarters includes a number of operational teams, not found in any other Army command," said Colonel Barry Lowe, Chief of Staff for the Command. "This presents unique challenges such as ensuring these teams receive the appropriate rest, training and reset time outlined in the Army's force generation model, known as ARFORGEN, as well as meeting unique training requirements for these very technical military and civilian forces."

WMD Coordination Elements, Nuclear Disablement Teams, Explosive Ordnance Disposal Teams and Chemical and Biological Response Teams are all part of the command's specialized assets, but when it comes to eliminating weapons of mass destruction these forces are not enough. Other assets from within DOD and other government agencies will partner with the CBRNE command to get the job done.

To help ensure the Army's specialized CBRNE forces are available when needed, all CONUS based Explosive Ordnance Disposal (EOD) and Chemical battalions will be aligned under the 20th Support Command (CBRNE). Both the EOD and Chemical structures are undergoing major force redesigns to ensure they have the personnel, equipment and training to meet the challenges on the battlefield of today. Aligning them under one headquarters also helps create efficiencies, enabling them to better align with ARFORGEN, and become more supportive to the Brigades Combat Teams and divisions they will deploy with.

Existing CONUS-based Army EOD forces under the 52d Ordnance Group (EOD) and the 22d Chemical Battalion (Technical Escort) joined the command when it activated in October 2004. Later, the 110th Chemical Battalion (Technical Escort) was activated in September 2005, and the 71st Ordnance Group (EOD) was activated in October 2005. When the 48th Chemical Brigade activates later this year, the remainder of the CONUS-based conventional chemical battalions and separate companies will become subordinate units of that new brigade.

Most of the operational capabilities of the Command are found in the chemical brigade and the two EOD groups, but the headquarters also has specialized operational teams to

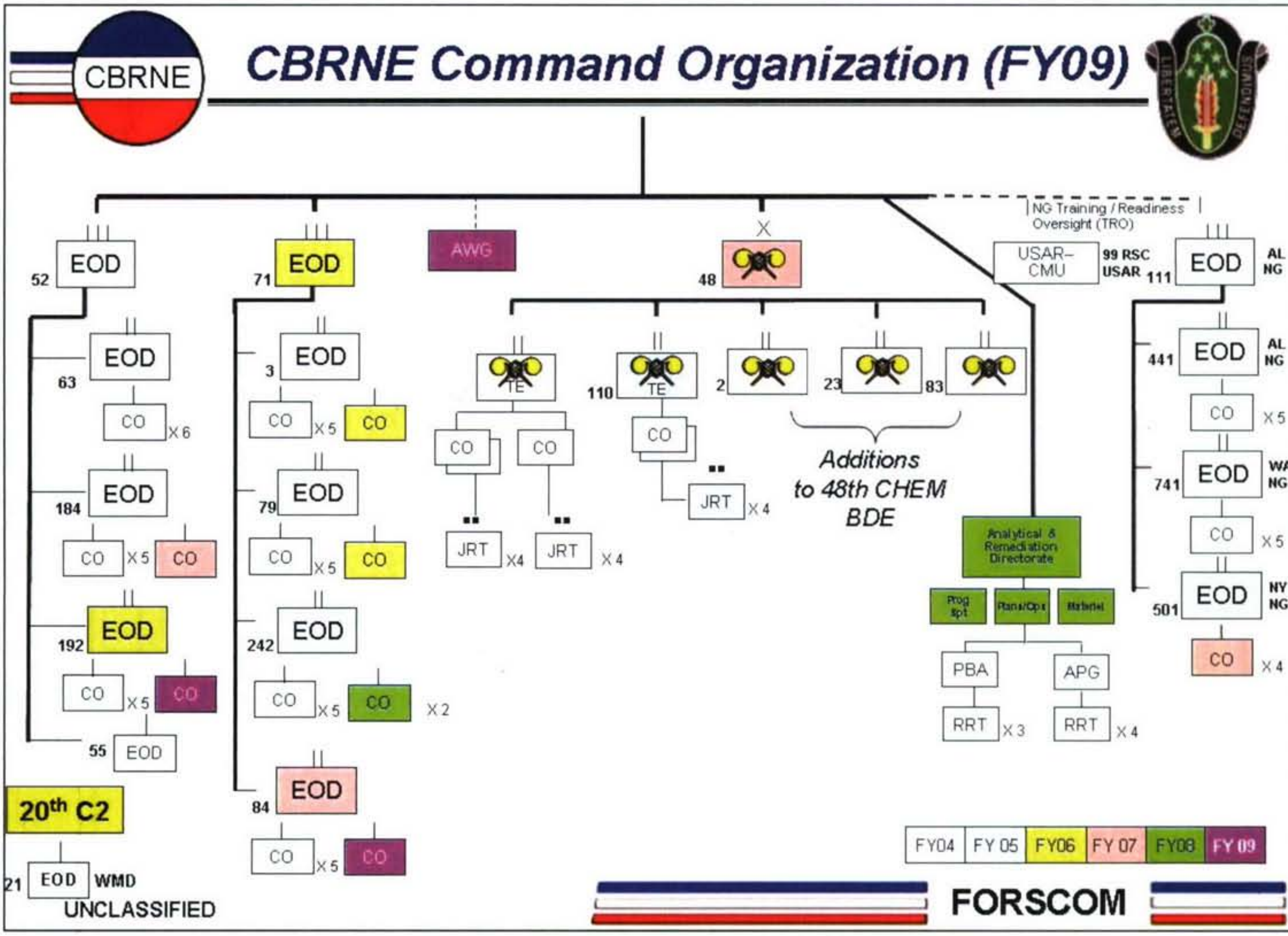


Figure 2. CBRNE Command (FY09) .

support the operational command post and other elements. See Figure 2. Cbrne Command (FY09) .

The WMD Coordination Elements, or CEs, from the headquarters are a liaison team that provides staff augmentation, technical subject matter expertise, planning support, and hazard modeling or prediction to Joint or Army Commanders. The standard CE configuration is built around Chemical, Nuclear, and EOD Officers and Soldiers, with organic intelligence and communications support. Additional on-call assets from other commands include biological and disease specialists, environmental scientists, and industrial hygienists. All CEs deploy with robust communications that include the worldwide technical reach back capability mentioned earlier.

Nuclear disablement teams are another operational asset embedded in the headquarters. These teams have the ability to exploit, dismantle, and disable nuclear WMD infrastructure (facilities); package, transport, and safeguard nuclear and/or radiological material that poses an immediate threat to friendly forces; collect and transport samples of radiological material or nuclear WMD intelligence for forensic analysis, and conduct sensitive site exploitation operations on identified nuclear sites.

Joint Staff and STRATCOM/SCC WMD modeling, CONOPs and mission analysis studies showed Service and Joint doctrine was inadequate while command and control relationships were ill-defined. Planning was insufficient and not integrated into training and exercise programs. Part of the solution to eliminate those capability-gaps was to establish a joint enabling capability for WMD-E in order to enable the rapid deployment of a JTF-E headquarters capable of providing command and control of exploitation and elimination operations. After much work with the Joint Staff, the Army staff, STRATCOM, JFCOM, and SCC WMD, approval was gained to stand up the Joint Elimination Coordination Element (JECE) (as a subordinate element of STRATCOM) and co-locate this outfit with the headquarters of the 20th SUPCOM (CBRNE). While the roles and missions of the JECE are still being defined, its broad function is to improve planning and coordination for WMD-Elimination operations, help this headquarters better support the combatant commanders, and to assist the 20th in rapidly forming a JTF-E when directed.

Another unique capability embedded within the 20th will be a deployable integrated lab. This lab will have

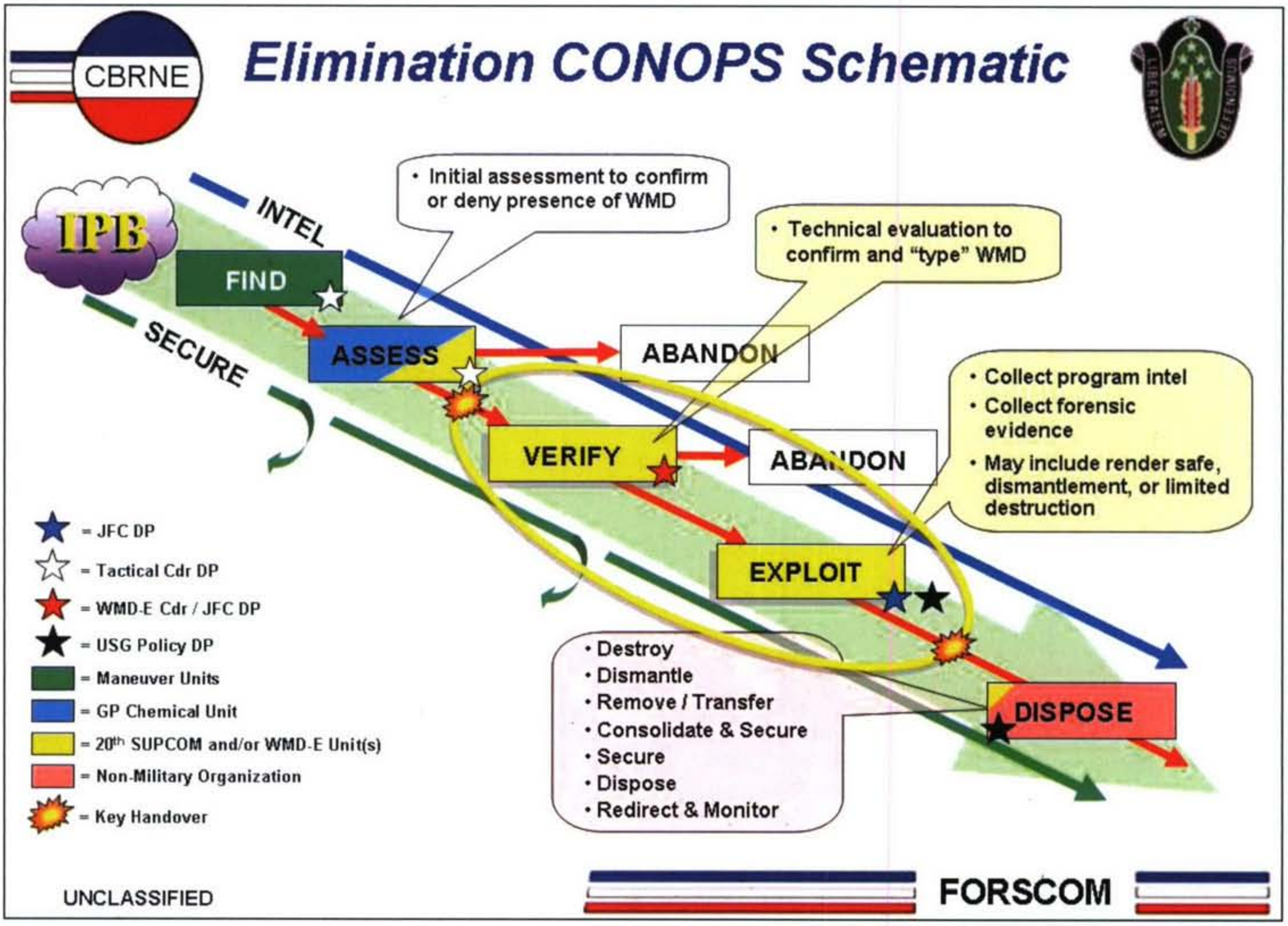


Figure 3. Elimination CONOPS Schematic.

the requisite equipment and personnel to analyze the full range of CBRNE threats, fused with a developing forensic and biometric capability. When fully operational, this lab will provide a chemical and biological analytical capability to provide timely, accurate analysis of unknown samples; as well as a near real-time chemical/biological monitoring platform.

The deployable labs will provide commanders in the field the timely information required to make operational decisions related to CBRNE hazards with a very high confidence of what the hazard is and the best methods to mitigate and eliminate that hazard. While this capability does not provide the "gold standard" of analysis that can be obtained from permanent, fixed laboratory structures in the U.S. and throughout the world, the mobile labs are efficient and effective in a tactical environment to provide more detailed or "silver standard" analysis commanders require. This is far beyond the capabilities of the standard military detection equipment presently in use. The mobile lab section of the 20th will also complement the capabilities found with both the medical and intelligence communities.

The final major operational element within the command headquarters is the Very Important Persons Protective Support Activity (VIPPSA), an element of this command that really works in direct support of JFCOM and JDOMS. The management of EOD protective assets and missions in support of the United States Secret Service has been the Army's responsibility for some time now. Whenever any individual designated as a VIP is traveling and needs to ensure no explosive hazard exists where they are, military explosive ordnance disposal technicians do much of the work and VIPPSA coordinates those efforts. These requirements continue with the support being shared across all of the services.

When you put these teams together with an operational command post that can provide intelligence, planning, and synchronization of operations, you have a WMD-elimination asset able to meet the requirements of the QDR and our nation. See Figure 3. Elimination Conops Schematic.

"Our number one priority is supporting the warfighter, providing trained and ready forces to execute a wide range of specialized CBRNE missions." said Brigadier General Kevin R. Wendel, Commander of the 20th Support Command. "Our transformation objectives will deliver a reli-

able, rapidly deployable and increased capability to Combatant Commanders to deal with WMD and CBRNE threats. We are building on some very effective, long-standing CBRNE capabilities that have been employed in every theater; this effort integrates, synchronizes, and is designed to deploy the right capability, at the right time and place."

"We have a strong network of partners who are helping us rapidly increase our capabilities and become better integrated into all of the potential responses to these threats," Wendel said.

The majority of the 20th Support Command's efforts are engaged in WMD counter-proliferation operations with a secondary mission in consequence management.

WMD-elimination sounds simple but is really a combination of a number of complex capabilities and synchronized efforts across DOD, and with many other government agencies as part of the National Strategy for Combating WMD and the National Military Strategy for Combating WMD. These strategies consist of three pillars – Non-Proliferation (NP), Counter-Proliferation (CP) and Consequence Management (CM). There are eight military mission areas under these three pillars: Threat Reduction Cooperation and Security Cooperation & Partnership Activities under the NP Pillar; Interdiction, Offensive Operations, Elimination, Active Defense, and Passive Defense under the CP Pillar; and Consequence Management under the CM Pillar.

Some of those agencies the Command provides support to and interacts with include STRATCOM, NORTHCOM, all the other geographic Combatant Commands, US Secret Service, Department of State, Department of Justice, DTRA, National Labs, R&D activities and technical reach back agencies like CMA, ECBC, COE, JIEDDO and DOD Program Boards, as well as training development with the Chemical School, the Ordnance School, and the Navy School of EOD.

WMD-elimination is defined as "Operations to support the systematic seizure, security, removal, disablement or destruction of a hostile state or non-state actor's capability to research, develop, test, produce, store, deploy, or employ WMD, delivery systems, related technologies, infrastructure and/or technical expertise." (JP 3-40)

"The 20th Support Command (CBRNE) is well suited to serve as the core of a joint command focused on WMD elimination," said Lt. Col. Steve Smith, who heads the command's coordination elements. "Many of the command's components (EOD, Tech Escort, and the Coordination Elements) currently provide capabilities to joint and multi-national commands and has both the joint experience and an established record of excellence in the joint arena."

Whether supporting a major combat operation, some other lesser scale CBRNE response, environmental cleanup operation, recovery of unexploded ordnance, or homeland defense support to civil authorities, this command ensures that when a CBRNE threat is encountered, specially trained and equipped military assets are available to respond, assess, mitigate and eliminate the hazard.

Additional information:
This article was prepared by the Public Affairs staff at the 20th Support Command (CBRNE). Additional information is available at the command web site at:
http://www.cbrne.army.mil/index.html

For Army officers and NCOs interested in finding out more about the command and assignment opportunities, please contact the following:
The senior EOD officer is the Deputy Commander, COL Paul Plemmons, DSN 584-0330. The senior Nuclear officer is the Chief of Staff, COL Barry Lowe, DSN 584-0330. The senior Chemical officer is the G3 Operations Officer, COL Ray Van Pelt, DSN 584-6226. The Command Sergeant Major is CSM Marvin Womack, DSN 584-0330.

WMD-elimination sounds simple but is really a combination of a number of complex capabilities and synchronized efforts across DOD, and with many other government agencies as part of the National Strategy for Combating WMD and the National Military Strategy for Combating WMD.

LIBERTATEM DEFENDIMUS

DODI 3222.3 and Army System HEMP Survivability

Robert A. Pfeffer, U.S. Army Nuclear and CWMD Agency

MAJ John L. Carter, Defense Threat Reduction Agency

Background

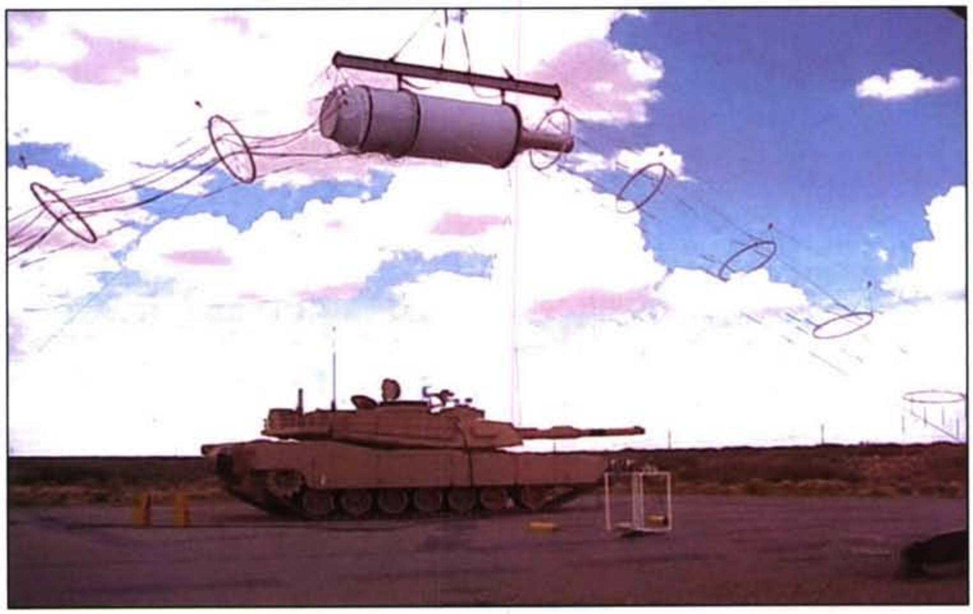
The conflicts of the 21st Century have brought significant change to the way the Army thinks and fights. The threat has changed, and with it the way the Army is structured. No longer is the emphasis on an all-out nuclear exchange with another superpower. Instead, the most likely conflict will be with less sophisticated enemies using less conventional methods of warfare. One can therefore conclude that future conflicts will be less decisive and could last for long periods of time.

At present, the strategic advantage of just using high tech to create "shock and awe" on concentrations of adversaries is gone. One must also use high tech on the extended battlefield to respond to small concentrations of adversaries who themselves use high tech commercial-off-the-shelf (COTS) electronics to communicate and detonate conventional munitions or relatively unsophisticated chemical, biological, radiological or nuclear weapons.

The one consistent thread between Cold War and 21st Century conflicts is the reliance on new technologies to improve the Army fighting capability. By far, the most dramatic revolution in technology has been in improved semiconductor technology. With it, subsystems have physically shrunk even while their capabilities have improved with lower power requirements. This improvement, unfortunately, is available to adversaries as well: cell phones are an example.

COTS electronics and electrical equipment provide the most advanced technology available for commercial and military applications. For the military, however, there are potential pitfalls of using just any COTS materiel solution. In the commercial arena, equipment life expectancy is four years or less in relatively benign environments, while military equipment is often used in harsher battlefield environments for longer periods of time. These environments include extreme heat and cold as well as severe electromagnetic environments (e.g., high-altitude electromagnetic pulse (HEMP)). Such recognition has prompted the Department of Defense (DOD) to direct additional requirements on all their electronic and electrical systems that support critical missions. One of these is the requirement that they operate in a wide range of electromagnetic environments and are protected from their associated electromagnetic environmental effects (E3).

This article provides the reader an overview of the evolving directive and instruction process and explains some of the immediate implications to new Army acquisitions and their E3 (including HEMP) control.



Abrams tank undergoing EMP testing

DOD Directives and Instructions

The Constitution of the United States establishes the framework for our government. The legislative branch then writes legislation and the executive branch signs or otherwise allows this legislation to become public law (e.g., Public Law 108-375, Ronald W. Reagan National Defense Authorization Act for FY2005). At the top of the directive pyramid, is the President, who issues classified or unclassified Presidential Directives

1000 – Manpower and Personnel (Civilian, Military, and Reserve)
2000 – International and Foreign Affairs
3000 – Plans and Operations, Research and Development, Intelligence, and Computer Language
4000 – Logistics, Natural Resources, and Environment
5000 – Acquisition and Administrative Management, Organizational Charters, Security, and Public and Administrative Affairs
6000 – Health
7000 – Budget, Finance, Audits, and Information Control
8000 – Information Management

Figure 1. DODD and DODI Major Subject Groups.

(PDs) or Executive Orders that explicitly identify executive priorities on national issues (e.g., National Security Presidential Directive 43/Homeland Security Presidential Directive 14, *Domestic Nuclear Detection*, April 2005). If those issues include military equipment and/or facility protection, for example, the DOD develops policy and implementation guidance called Directives and Instructions. DOD Directives (DODDs) are the formal process used by DOD to provide broad policy guidance on specific issues of concern to the SECDEF and the President. Directives state the issue and identify the responsibilities of OSD and subordinate organizations. Policy implementation guidance is then given in associated DOD Instructions (DODIs). Historically, both Directives and Instructions are divided into eight subject groups.

One subject group known to most of the nuclear weapons effects (NWE) community is the 5000 series. DODD 5000.1 stated (in E1.10. *Information Superiority.)* "Acquisition managers shall provide U.S. Forces with systems and families of systems that are secure, reliable, interoperable, compatible with the electromagnetic spectrum environment, and able to communicate across a universal information technology infrastructure, including NSS, consisting of data, information, processes, organizational interactions, skills, analytical expertise, other systems, networks, and information exchange capabilities." To implement the directive, the Joint Staff prepared the Chairman of the Joint Chiefs of Staff Manual 3170.01B. With this guidance each Service prepared its own implementing documents called regulations. For the Army, Army Regulation (AR) 70-75 is the current implementing regulation for NWE (including HEMP) survivability.

Typical Military EMP Hardened equipment Photo: Ft. Monmouth

DODD 3222.3

DODD 3222.3 is a 3000 series Directive. It is entitled Electromagnetic Environmental Effects (E3) Program and has an effective date of 8 September 2004. The Directive was updated September 2005.

DODD 3222.3, 8 September 2004, supersedes DODD 3222.3, Department of Defense Electromagnetic Compatibility Program, 20 August 1990. It was reissued "...to update policy and responsibilities for the management and implementation of the DOD Electromagnetic Environmental Effects (E3) Program to en-

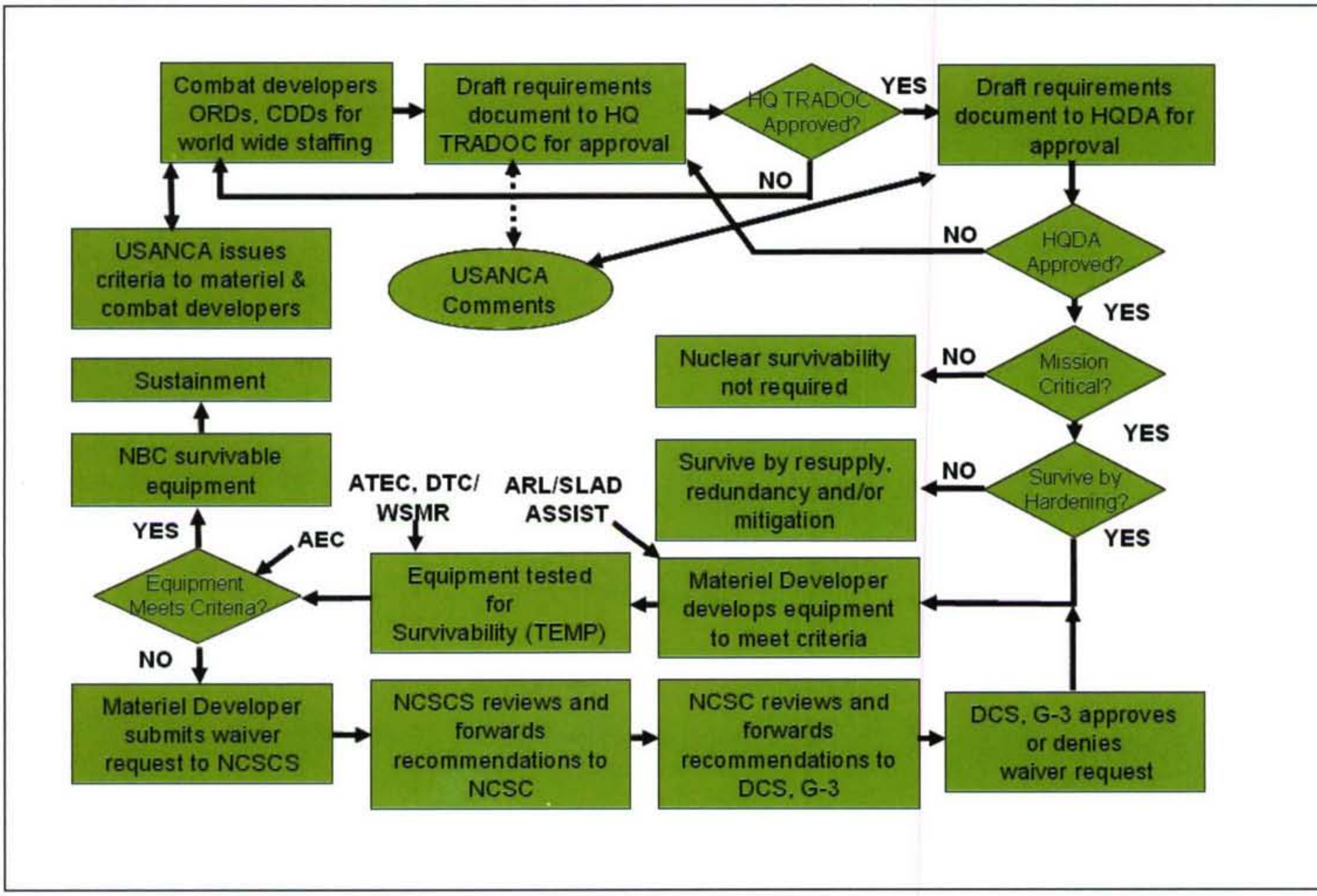


Figure 2. Typical Nuclear Survivability Program Flow Diagram.

sure mutual electromagnetic compatibility (EMC) and effective E3 control among ground, air, sea and space-based electronics and electrical systems, subsystems and equipment, and with the existing natural and man-made electromagnetic environment (EME)."[1]

The directive explicitly identifies a five-part policy:

1. "All electrical and electronic systems, subsystems, and equipment, including ordnance containing electrically initiated devices, shall be mutually compatible in their intended EME (electromagnetic environment) without causing or suffering unacceptable mission degradation due to E3."[2]

2. "Military E3 specifications, standards, and handbooks stressing interface and verification requirements, establishing operational performance, and specifying developmental and operational test methodologies shall be developed following guidance outlined in DOD 4120.24."[2]

3. "Analytical tools and databases for EMC analysis and E3 assessment shall be developed and maintained to predict, prevent, and correct E3 deficiencies of military systems in the intended operational EME."[2]

4. "The Department of Defense shall maintain measurement capability to quantify E3 of military systems to and from their intended operational EME."[2]

5. "E3 awareness and training shall be promulgated throughout the Department of Defense."[2]

DODI 3222.3

Supporting this directive will be DOD Instruction (DODI) 3222.3. Originally scheduled for completion in 2006 by the Joint Spectrum Center (they also prepared the Directive for the Assistant Secretary of Defense for Networks and Information Integration (ASD(NII)), the Instruction lays out the Directive implementation process. It is now scheduled for release in 2007 (see additional comments in the postscript).

Army HEMP Survivability

Congress, in reestablishing the 2004 EMP Commission, reiterated its concern for homeland security by raising the issue of HEMP protection of our national assets, especially those supporting critical missions. That concern, plus the implementation and enforcement of DODD 3222.3 and DODI 3222.3, should have a significant impact on Service acquisitions. For example, the well documented Legacy equipment audit trail for Army NWE survivability will be strengthened by the DODD 3222.3 statement that HEMP survivability is now an operational requirement.

This conclusion leads to the following:

- DOD will enforce E3 protection through the DOD Directive and Instruction process
- E3 (including HEMP) protection cannot be traded off because it is now an operational requirement E3 protection must be applied to manned platforms and systems and to unmanned platforms and systems that keep personnel out of harm's way.

Since the 60's the Army has exercised a NWE survivability program that included survivability to HEMP. Its success was due, in part, to the audit trail established to monitor the progress of new systems that support Army critical missions. A typical flow diagram is shown in Figure 2 , (see previous page).

New Army acquisitions that have a NWE survivability requirement and that have to meet that requirement through hardware protection must, at a minimum, survive the high-altitude EMP (HEMP) environment specified in Military Standard (MIL-STD) 2169B. Over the years, this requirement has not been a major cost driver for new Army systems; in fact, a survey of several legacy equipment acquisition programs shows they met the NWE survivability requirement for less than three percent of the total system cost. Of that three per cent, HEMP hardening costs accounted for about one percent. This modest increase in per-unit cost usually means few program managers request a HEMP criteria waiver. A look at the Army HEMP survivability records kept at USANCA shows only one system, the Intermediate Forward Test Equipment, was ever granted a HEMP criteria waiver.

Future Impact to Army/Service Acquisition Programs

If properly enforced, DODD 3222.3 and the new DODI 3222.3 will further strengthen the existing NWE survivability document trail. One can now read into DODD 3222.3 that the HEMP survivability requirement is now an operational requirement that must be met by <u>all</u> military electronic and electrical systems, not just those that support a critical mission. This implies E3 protection from such EMEs as HEMP, HPM, and ESD are no longer in the trade space for materiel developers.

In addition, by addressing E3 protection in a single directive, DODD 3222.3 will encourage system designers to design in all E3 protection at the same time, thus sharing and even reducing E3 protection costs. This protection philosophy is consistent with the unified approach to ElectroMagnetic Environmental Effects Protection discussed in QSTAG 1051[3] (see Fall/Winter 1999 NBC Report article, p. 25, Reducing Army EM Protection Costs) and used in the aircraft hardening MIL-STD (under development).

Summary

- "DOD Directives establish or describe policy, programs, and organizations; define missions; provide authority; and assign responsibilities."[4]
- DODD 3222.3 is the first Directive that specifically deals with EMC and E3 control of all electronic and electrical systems. More importantly, it places an operational requirement on E3 (including HEMP) survivability, thus taking it out of the trade space traditionally associated with NWE survivability.
- DODD 3222.3 could have a significant technical and monetary impact on future Army equipment acquisitions.

DODI 3222.3 is presently in draft form. It is now scheduled for release in 2007.

Postscript

During the preparation of this article the author learned of two new initiatives. The first is the result of a recent policy memo from DSD Gordon England. In the memo, future DOD Directives and Instructions will be written as one document and will be called DOD Instruction. Thus, the existing DODD 3222.3 will be cancelled and the DODI 3222.3 now being written will be revised to include both DODD 3222.3 and DODI 3222.3 information.

In addition, ATSD(NCB) is now preparing a draft DODI on HEMP protection of military systems. This document and the current investigations of the Defense Science Board and Army Science Board on HEMP protection will be the subject of a future article.

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Further Reading:

1.https://acc.dau.mil/CommunityBrowser.aspx?id=30512
2. http://www.dtic.mil/whs/directives/corres/html/32223.htm
3. Quadripartite Standardization Agreement (QSTAG) 1051, edition 1; American, British, Canadian, Australian Armies' Standardization Program; 6 October 1998.
4. http://www.fas.org/irp/doddir/dod/index.html

DARPA Urban Grand Challenge 2007

Robert A. Pfeffer, Physical Scientist

No more negotiating the 1.5-mile Beer Bottle Pass thru the Lucy Gray Mountains of the southern Mojave Desert: the next Defense Advanced Research Projects Agency (DARPA) Grand Challenge moves to the city!

After the impressive success of DARPA Grand Challenge 2005 (see Spring/Summer 2006 NBC Report), DARPA will sponsor a third competition on 3 November 2007, this time realistically simulating safe operation of autonomous vehicles on a 60-mile mock urban area course. The first competitor to cross the finish line in less than six hours will win $2 million. Second prize is $1 million, and third prize is $500 thousand. If there are favorites in this one, consider the entries from Stanford University and Carnegie Mellon University.

On 20 May 2006 DARPA held an Urban Challenge Participants Conference in Reston, VA to outline to potential entrants the Grand Challenge 2007 details. Of particular interest was the course provided in the solicitation notice:

"At the capstone event, performers will demonstrate a vehicle that exhibits the following behaviors: safe vehicle-following; operation with oncoming traffic; queuing at traffic signals; merging with moving traffic; left-turn across traffic; right-of-way and precedence observance at intersections; proper use of directional signals, brake lights, and reverse lights; passing of moving vehicles; and all the other behaviors implicit in the problem statement. Vehicles will also demonstrate navigation with limited waypoints and safe operation in complex areas such as parking lots. Recognition of traffic signals, street signs or pavement markings is considered outside the scope of the program, as this information will be furnished by DARPA. High-speed highway driving is also outside the scope of the program."

I know some people that would find this course a challenge.

Originally mandated by Congress and the DOD, the DARPA Grand Challenge is a field test intended to accelerate research and development in autonomous ground vehicles to save lives on the battlefield. With even modest success in the urban environment, next-generation autonomous vehicles armed with Grand Challenge technology could be a major part of the future Army fighting force, especially in software engineering and such integration concepts as drive-by-wire.

This growing interest in autonomous vehicles is not unique to the US Army. In 2006 Europe conducted their version of the Grand Challenge called Robotic Challenge. It was held in Germany in May and consisted of three different events: urban, non-urban, and landmine detection and removal scenarios. Unlike all three Grand Challenges, the European Robotic Challenge entries were not required to be autonomous – semi-autonomous and even remotely operated vehicles were allowed to compete. Thus far, no event results are available.

The Stanford University entry and GC 2005 winner Stanley.
Can it repeat in GC 2007?
Photo by Stanford University.

Further Reading:
Spring/Summer 2006 NBC Report .
The official DARPA Grand Challenge web site
http://www.grandchallenge.org. or
Google search on DARPA Grand Challenge

Davis Gun: Simulation of Severe Mechanical Environments

Roy S. Baty, LANL

Ron Lundgren, Applied Research Associates, Inc.

Garth Reader, Lawrence Brooks, and Peter Sandoval, LANL

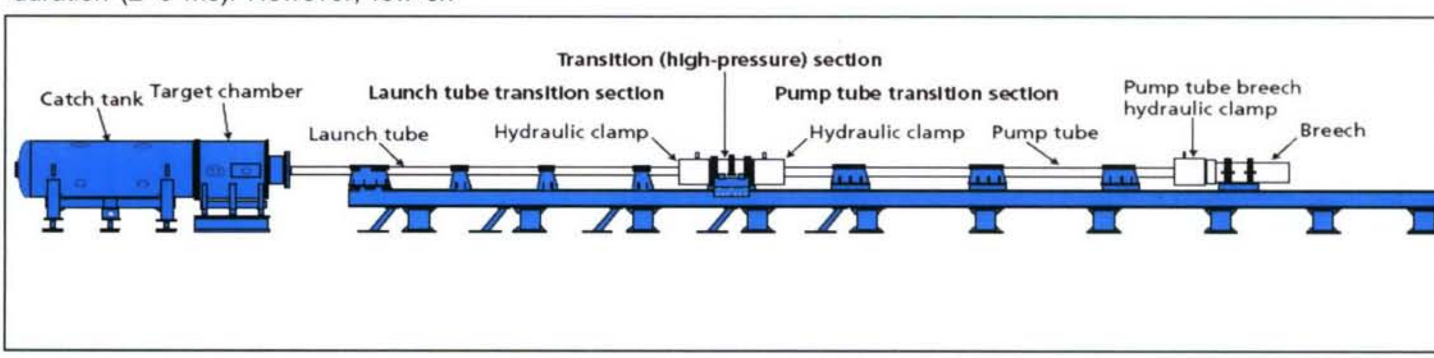
Impact deceleration events are challenging to measure and quantify. However, the Davis gun project team can simulate deceleration events by tailoring acceleration events in which experimental variables can be controlled. This research is timely because an experimental method that successfully simulates decelerations for test articles weighing up to 2000 lb would have significant application in a wide range of severe impact and vibration environments for weapon development and certification.

Several experimental methods for weapon testing can simulate large deceleration environments for short duration (2–3 ms). However, few experimental methods are available to simulate large deceleration environments for long duration (intervals of at least 10 ms).

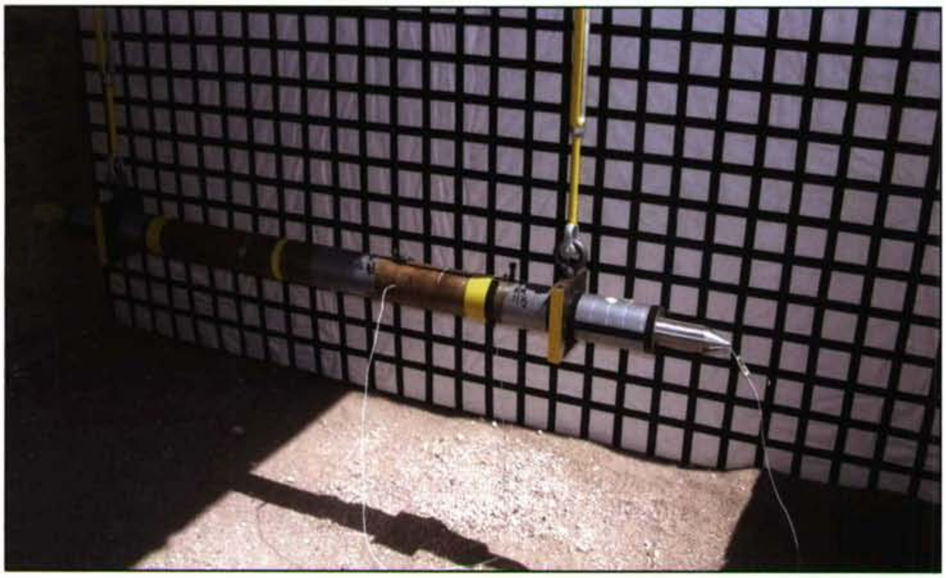
In large-caliber guns, the launch accelerations of the projectiles are repeatable to within a few percent from shot to shot, making them a very useful experimental tool for studying severe mechanical environments. We define a severe mechanical environment as a deceleration of full-scale components or subsystems of up to 2,000 times the force of gravity (2,000 *g*'s) for 10 ms. The Davis gun is commonly used for earth-penetrating weapon (EPW) development. The original Davis gun was a large-caliber recoilless cannon invented by Commander Cleland Davis of the US Navy in 1912 for use against naval craft and ground targets. A Davis gun is recoilless because it fires two masses simultaneously out of each end of an open gun tube: a projectile is fired out of one end of the gun, and a reaction mass is fired out of the other end.

The technical goal of our research is to determine if a Davis gun launch environment can be tailored to simulate the severe mechanical environment of an EPW impact event. In principle, if acceleration rise time could be shortened and a superposition of pressure pulses could produce a constant acceleration for 5–10 ms, the Davis gun could generate a nearly square-wave acceleration pulse, which would be an excellent simulation of an EPW impact deceleration event. That is, on impact an EPW experiences a sudden deceleration that, when graphed, rises quickly to an amplitude that persists for 5-10 ms and then abruptly falls to zero.

Historically, Sandia National Laboratories (SNL) maintained and operated the Davis guns used in Nuclear Weapons Complex programs. The SNL Davis guns are now maintained and operated by the Energetic Materials Research and Testing Center (EMRTC) of the New Mexico Institute of Mining and Technology (NM Tech) in Socorro, New Mexico. SNL has 8–, 12–, and 16–in.-bore Davis guns, while EMRTC has its own 2–, 6–, and 15–in. Davis guns. Applied Research Associates (ARA) also participates in the Davis gun tests at NM Tech. The SNL/EMRTC Davis gun capability is unique in the US.



The goal of this research is to produce Davis gun accelerations that simulate earth penetration decelerations.



The 2–in. Davis gun suspended on a ballistic pendulum. The reaction mass protrudes from the gun barrel on the right. Accelerometer wires attached to the noses of the projectile and reaction mass led to oscilloscopes, and the two wires near the middle of the gun were for pressure transducer measurements. The ignition wires are not shown. The 4-in. grid behind the gun shows any movement of the gun during a shot and provides a reference background for real-time video.

similar to a multiple rocket motor assembly with four parallel propellant tubes, one or more of them loaded with black powder. Each tube in the charge bank could be loaded and fired independently of the other three tubes. For each shot, we loaded a charge bank and inserted it into the gun tube between the projectile and the reaction mass. The charge bank attached to the gun tube with two bolts screwed into the barrel from the outside surface of the gun. A hole drilled through one of the attachment bolts provided wiring access into each propellant tube. Very light end caps closed the ends of the charge bank tubes. We ignited the multiple tubes of the charge bank in sequence using an individual fire set for each tube, timed with a Stanford signal generator.

Each shot in the test series fired a projectile and reaction mass. Commander Davis used a reaction mass consisting of grease and lead shot; we

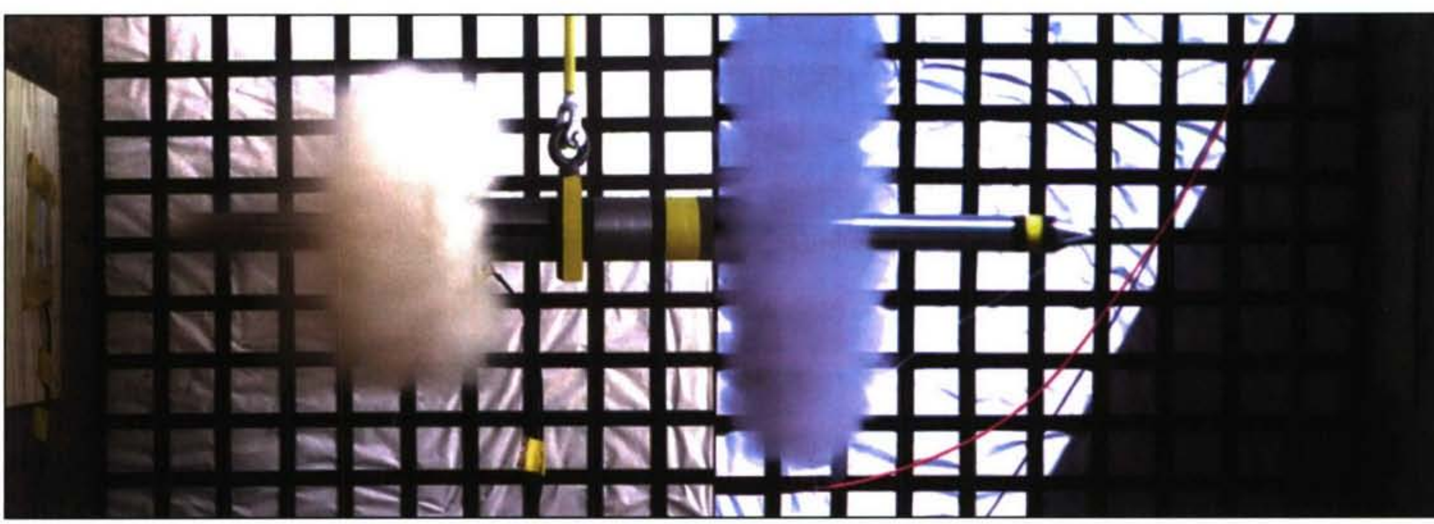
The Davis gun four-tube charge bank assembly. Each tube, loaded with black powder, could be fired independently. The charge bank was 12 in. long and fit inside the 2–in.–i.d. Davis gun.

For our feasibility study, we performed a five-shot subscale Davis gun test series at EMRTC with an approximately 60–in.–long EMRTC gun that had a 2–in. bore. The gun was hung on a ballistic pendulum to provide a qualitative check that the momentums of the projectile and reaction mass were balanced.

To generate a superposed pressure pulse to tailor the projectile and reaction mass launch accelerations, we designed and built a 12–in.–long, four-tube charge bank to fit inside the 2–in. Davis gun tube. The charge bank was used a machined projectile shape as reaction mass because we wanted to take pressure, acceleration, video (against a lattice background), and other measurements from it as well as from the projectile. We designed both the projectile and reaction mass as cone-nosed soil penetrators and fabricated them from 304 stainless steel. The projectile weighed 3.9 lb, while the reaction mass weighed 12.3 lb. We instrumented both the projectile and reaction mass with accelerometers to measure axial launch accelerations.

In each shot, we fired the projectile and the reaction

The reaction mass (top) and projectile (bottom) fired from the Davis gun, with accelerometer wires attached to their nose cones. The reaction mass weighed 12.3 lb, and the projectile weighed 3.9 lb. Each had three lengthwise grooves for phenolic resin runners that provided support in the gun barrel and reduced friction. Plastic disks (not shown) at the base ends of the reaction mass and projectile acted as pressure seals.

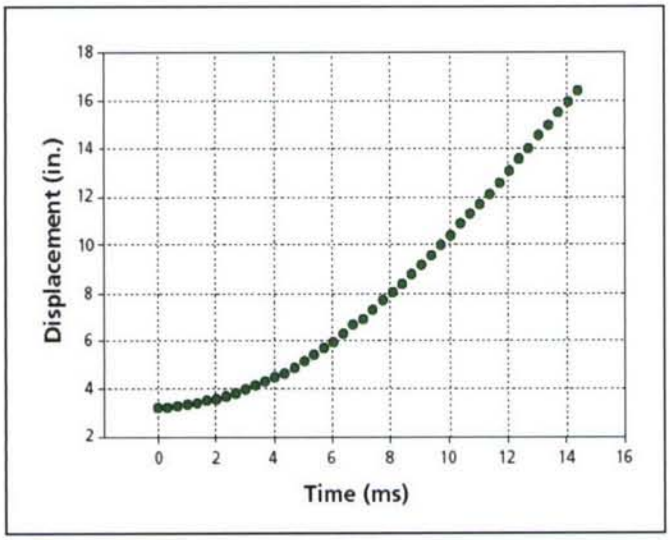


A typical composite high-speed video photograph showing the projectile (*left*) and reaction mass (*right*) just after they exited the Davis gun tube. The black powder gases appear to be of different colors because of differences in the available lighting. The real-time video showed that the Davis gun exhibited little to no pendulum motion during the five test shots, indicating that the momentums of the projectile and reaction mass were balanced.

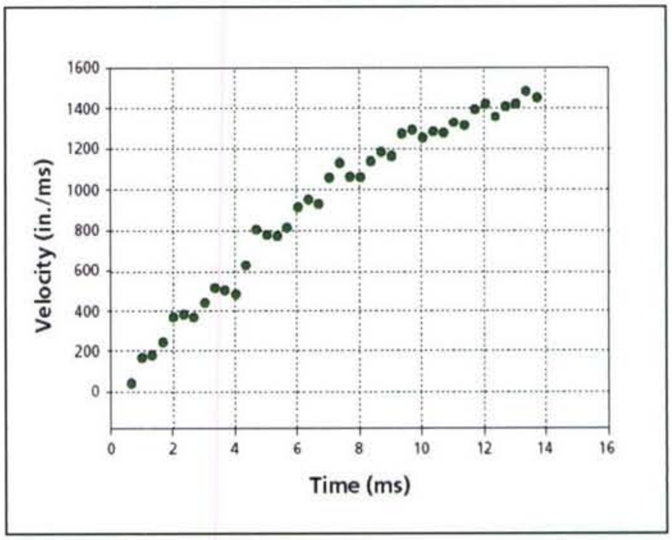
mass into two plywood boxes that were 4 ft in each dimension. The boxes were open at the top and were filled with sand. In each shot, we recorded both high-speed video and real-time video. Additional test instrumentation measured the ignition times and timing delays and the approximate times that the projectile exited the gun barrel and impacted the outer surface of the target box. All tests used FFF black powder. (The F designations for black powder indicate the screen sizes—and resultant grain sizes—used in manufacturing the black powder, with FFF being smaller and faster-burning than F and FF.) The five-shot test series included shots that fired one, two, and three tubes of the charge bank with ignition delays of up to 5.0 ms:

- Test 1: single charge
- Test 2: two charges, no ignition delay, pulse superposition
- Test 3: two charges, one at a 3.5-ms ignition delay, pulse superposition

Video photograph showing the projectile as it exited the Davis gun tube. The shroud of hot propellant gases enveloping the projectile made video measurements difficult: in fact, the reaction mass provided better measurements because its nose cone already protruded from the gun barrel before firing and so traversed clear air ahead of propellant gases.



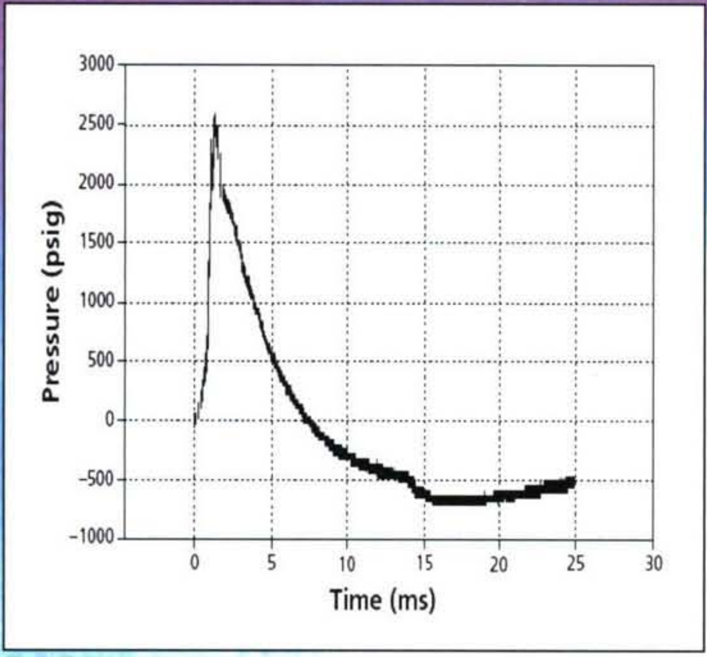
Measured reaction mass displacement in inches from the Davis gun barrel as a function of ignition time in milliseconds. For this shot, two tubes of the charge bank were fired with a 5.0–ms delay. Displacement data are useful because reaction mass velocity can be computed from such data.



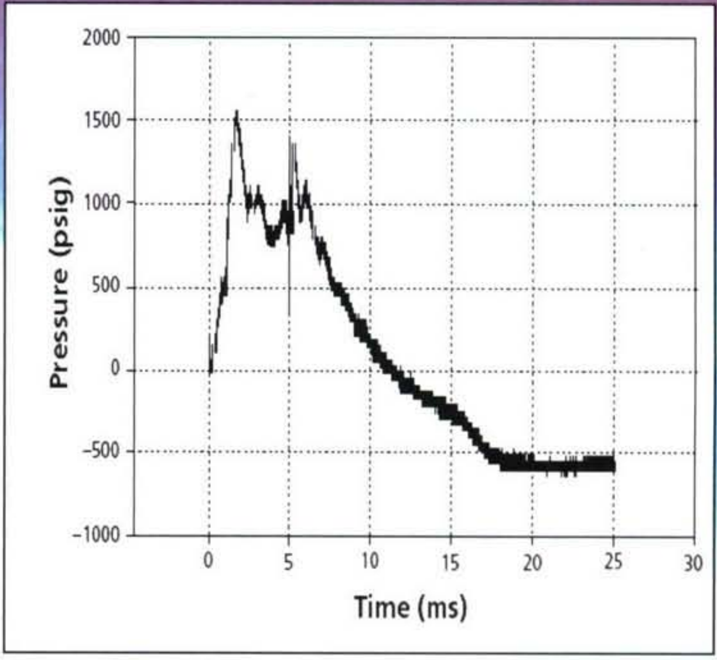
Reaction mass velocity computed from displacement data for a shot in which two tubes of the charge bank were fired with a 5.0–ms delay. Scatter in the velocity approximation is attributable to jitter in the video position-time data.

- Test 4: two charges, one at a 5.0-ms ignition delay, pulse superposition
- Test 5: three charges, two at 5.0-ms ignition delays, pulse superposition.

When the reaction mass was loaded into the Davis gun, its nose protruded from the end of the gun tube and was visible from time zero forward. Therefore, we obtained good displacement (position-time) measurements for the reaction mass from the high-speed video on all five tests. No direct position-time data were obtained for the projectile from the high-speed video. This was expected because the projectile was inside the barrel for almost the entire time interval of interest, and when the projectile did emerge, it was shrouded in propellant gases.



Measured Davis gun chamber pressure for a shot in which one tube of the charge bank was fired to provide a baseline for multiple-tube shots. Of particular interest here is the pressure rise time because it is one of the variables we want to tailor to simulate an acceleration square wave.



Measured Davis gun chamber pressure for a shot in which two tubes of the charge bank were fired with a 5.0–ms delay. Fast-burning black powder is fired in two or more tubes to achieve both a rapid rise time and pressures that remain high for up to 10 ms. The goal of tailoring the pressure pulse is to produce an acceleration pulse that approximates a square wave such as occurs during projectile earth-penetration deceleration.

Because the subscale Davis gun shots exhibited little recoil on the real-time video, the motion of the projectile can be closely estimated from the motion of the reaction mass by assuming that the momentums of projectile and reaction mass are equal. We used a symmetrical, four-point, finite-difference formula to compute the velocity of the reaction mass. The scatter in the velocity approximation is due to jitter in the visual position-time data. Applying the velocity estimate to the projectile, assuming that the momentum of the projectile and reaction mass are equal, indicates that the projectile experienced an average acceleration of around 1100 *g*'s over the first 3 ms of the shot in test 4.

In addition to the position-time data, we measured time-dependent gun chamber pressures for each shot in the test series. We used two pressure transducers in the Davis gun chamber, one located near the initial position of the projectile base and one located near the initial position of the reaction mass base. The pressure data show that the initial rise time of the pressure pulse can be shortened as a function of the propellant amount and burn rate. The pressure data also show that the charge bank design allows individual propellant tubes to be ignited with timing delays to produce superposed pressure pulses. The decrease of the pressure rise time and the use of ignition timing delays and pressure pulse superposition indicate that a 2–in. Davis gun tube acceleration pulse may indeed be modified to have some of the features of an idealized square-wave acceleration pulse.

The next step in this research will be to tailor a specified pressure pulse by using timing delays and pressure superposition. This approach will provide insight into how to generate a gun tube acceleration pulse that approximates a square wave. In concert with the pressure pulse tailoring, research will begin to extend the charge bank concept and design to a 6–in. Davis gun.

The severe mechanical environment of interest will be simulated by the launch acceleration in the gun tubes using a reverse ballistics technique. The test articles will be orientated backwards along the centerline inside the projectiles fired from the Davis guns. The test projectile will be shot into a soft target, inducing a well-defined deceleration on the projectile and test article of a substantially lower magnitude than the gun tube launch acceleration. To test EPW components, a reliable soft catch target can be constructed from layered plywood and sand. A 6–in. Davis gun will allow projectiles large enough in diameter to carry self-contained data recorders and test small components and materials samples in severe mechanical environments.

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Also contributing to this research were Ron Lundgren (Applied Research Associates, Inc.) and Garth Reader, Lawrence Brooks, and Peter Sandoval (LANL).

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Developing Decon Procedures, A Primer for Army Program Managers

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As technology advances and weapon systems become more sophisticated, the need is increasing for development of specialized procedures to decontaminate more complex and sensitive military equipment. Special tactics, techniques, and procedures (TTPs) for decontamination operations are developed for certain systems and equipment used by the soldier on the battlefield. If the current decon (decontamination) procedures are too general under FM 3-11.5 or in the equipment manuals and a deficiency exists, a TTP must be developed.

Program managers (PMs) responsible for fielding Army systems must ensure that mission-critical systems are decontaminable under AR 70-75 survivability regulation dealing with chemical, biological, and radiological (CBR) contamination. Program managers often request guidance from USANCA on how to proceed to develop decon TTPs for their new or improved system.

Frequent questions include: "What are TTPs and how are they developed? When does a system need to have TTPs? Where to go to develop decon TTPs for my system? What are the acceptable contents and who approves them? Do you have a template?" This article addresses these questions, while focusing chiefly on decontamination problems that need special attention.

Definition. TTPs are a set of instructions designed specifically for a system or item of equipment. For decontamination, essentially the ideal TTP delineates procedures to accomplish field decon or simply to avoid contamination of an item. They should also contain training procedures for all military in joint forces operations and for civilian first response teams.

Purpose. TTPs are written primarily for use by the unit or Soldier – the ultimate user of the item in combat. They are intended for the decon unit that comes in to accomplish Thorough decon on the system. The ultimate goal of a good set of decon TTPs is to protect Soldiers by reducing contamination levels, allowing field operations to continue by unprotected personnel. The final output is a new decon procedure specific for the system, followed by formal inclusion in the equipment training manual (TM) or field manual (FM).

Requirement. If there is a requirement written into a document, such as the Capability Development Document, then the mission critical system must comply with regulations and criteria in AR 70-75 Survivability of Army Personnel and Materiel. The requirement is normally written by the combat and materiel developers. After the system is tested and evaluated against those criteria, a TTP is required if a deficiency or shortfall is identified during the decon procedures and the system does not meet the requirements. A deficiency may also be discovered during re-evaluation of a legacy system, or when a CBR engineering analysis (paper study) is performed on a system or equipment. Essentially, survivability criteria that are not met can be compensated by appropriate TTPs for the system. However, the mere statement that a problem will be addressed using TTPs is not sufficient, and the PM must show the documented decon procedures for the system or equipment. Often the necessary procedures are not fully covered in published FMs available to the warfighter. Still another reason to require TTPs occurs when a PM requests a waiver on particular military equipment that does not meet AR 70-75 survivability criteria, [1] and then an authority such as the Army G-3 imposes a condition or caveat that goes with the waiver. These are typical reasons that may trigger the need for developing a set of TTPs and that must be considered before submitting a request for waiver.

Developing TTPs

Currently, there is no generic template or recipe to prepare TTPs for decon procedures. Each procedure must be specifically tailored for the particular system or equipment item. The basic contents of TTPs for a system must include <u>**how**</u> the system's shortcomings are addressed (unless it is for normal routine tasks by the decon unit). The development of techniques and procedures normally follows the steps in Table 1 (see following page). Each step is briefly explained in this article.

TTPs are necessary when a gap or failure has been recognized during an evaluation or testing effort using

Table 1. Steps for TTPs Development.

o Recognition of a need to develop or refine specific TTPs to decon the system.
o Gathering of information based on full knowledge of the system.
o Development of step-by-step procedures specific for that item or system.
o Identify locations where decon is more difficult.
o Techniques to mitigate and accomplish decon operations.
o Review of procedures by experts on the system.
o Test prove out and approval of TTPs for the system or equipment.
o Implementation of TTPs in field or technical manuals or documentation for the system.

test operations procedures. The main goal is to provide detailed information as to what is the best approach to decon that equipment. The TTPs must offer procedures to mitigate those decon gaps or deficiencies.

Figure 1. Soldiers learning new decon TTPs using the M17 Decon System.

The initial action rests with the PM group who is responsible to develop procedures to fill any decon gap(s) before fielding the system. The PM shop must first coordinate with the Combat Developer (CBTDEV) -- the Army entity whose personnel have the most knowledge or have developed the operational requirements for the equipment or system. CBTDEV makes the determination if the equipment is mission critical and requires hardening. In this case the survivability requirement can be met via operational TTPs, which specify if the gap or shortcoming can be solved by mitigation, redundancy, or resupply.

Coordination on specific decon procedures and other technical issues are done with testers and evaluators such as Dugway Proving Ground (DPG), Army Evaluation Center (AEC), Army Research Laboratory (ARL), and other agencies that identified the deficiencies. While Army-wide problems are identified by evaluators, system specific fixes are recommended for implementation through TTPs.

When developing decon procedures for a system, initially one needs to consult the approved decontamination procedures in FM 3-11.5. However, the manual procedures are too general for use in most sophisticated or sensitive equipment, particularly those equipped with electronics, computers, plastics, avionics, or hard to reach areas or crevices (nooks and crannies). For fielded systems the decon procedures are contained in the back of operations manuals. The back section of FM 3-11.5 also contains decon procedures for some particular platforms. But some of the current decon procedures are harsh and normally result in degradation of sensitive equipment. In the case of a platform with sensitive equipment, one must take into consideration its engineering configuration, materials of construction, and how the components are assembled. A technical examination of the equipment by testers and evaluators will give a "better feel" on how to develop the specifics to include in the TTPs.

When appropriately developed, TTPs are incorporated in TMs and FMs. Through these manuals the PM conveys to the soldier those proven techniques that mitigate decon problems on the system. For instance, a component X of a system is typically damaged by Y decontaminant. As such, there is a need to first clean it using Z, then cover to protect it while decontaminating the surrounding areas. In all cases, the TTPs must provide detailed information on the best approach and equipment to decon the system or item of equipment. Figure 1 shows Soldiers learning new decon procedures to eventually develop TTPs.

While the Multiservice FM 3-11.5 may serve as a guide for decon procedures, TTPs can *not* be a simple regurgitation of wordings from that manual; but rather a methodic approach consisting of thought out steps or technical procedures designed with that particular mission-critical equipment in mind. TTPs must address the engineering design and components peculiar to the system, and how a soldier will proceed safely during the decon process in an

Figure 2. Soldiers in MOPP IV gear practicing decon operations to develop new TTPs.

operational environment.

Thorough research must be conducted on the system to determine what is available that could be used during development of special decon procedures. For instance, if the AR 70-75 survivability test or assessment has been performed on the equipment, the test result is a source of valuable information because it may identify areas that are more difficult to decon. There might be other publications or test reports on the system containing specific information about decon requirements or procedures for newly added equipment in latest versions. Normally, a CBRN test report indicates whether the equipment is decontaminable to safe levels in the DA-approved criteria, and where potential decon problems exist. A TTP needs to address the issue when the system is not decontaminable down to a negligible risk level, and must provide quick fixes. It must emphasize troop safety procedures including stand-off, crew rotation, protective clothing, and monitoring. It can also indicate how long it typically takes for the system to air-out and self-decon, or if it will continue to present a hazard to unprotected individuals on the battlefield.

TTPs should contain information on how to conduct immediate, operational and thorough decon for the system. The procedures must be presented in an easily, concise language on how the techniques mitigate and accomplish the decon operation. TTPs must indicate if a battalion, a team or only an individual is sufficient to complete the decon process, and what equipment is needed to accomplish the tasks successfully. A fallacy in TTPs is to simply state that "thorough decon will eliminate all CBR agent hazards." It will not. Often a thorough decon does help to reduce the contamination considerably for personnel working, maintaining, and resupplying the system. But in some cases the equipment needs more than one cycle of thorough decon or needs time to weather out to render it below negligible risk values. For example, after one decon cycle, some existing gaps, crevices, engine compartments or absorbent materials may still remain a hazard to the warfighter. In all cases, the TTPs need to show specific provisions to decon these hard-to-reach surfaces. The TTPs preparer makes a judgment on this aspect.

Field samplers for liquid and vapor offgassing of agents show the level of decon, and are useful to indicate "how clean is clean". For instance, if the extent of contamination on vehicle rubber tires is unknown, point detectors are used to establish the vapor levels before soldiers can unmask. Also, secondary contamination issues, which can easily be addressed in TTPs, occur when a contaminated individual transfers contaminants to a non-contaminated surface. A typical case is when a contaminated soldier in mission oriented protective posture (MOPP) gear enters a vehicle or shelter to perform an operation, or if a vehicle travels through a contaminated area and the agent contaminants are transferred to clean surfaces. The TTPs must have warnings indicating if the item remains a health hazard to the crew, soldier units or maintenance personnel for extended periods of time after decon is completed. Perhaps the appropriate wording such as, "The crew (squad or maintainers) are required to remain in MOPP IV level after hasty or thorough decon until the hazard is reduced to a safe level." Additionally, FMs often specify what protection level is the most appropriate to wear during the decon process. A planned MOPP demo can verify those developed TTPs to ensure the ability of the operators to continue the assigned mission wearing MOPP gear in a contaminated environment. Figures 2 and 3 show soldiers in MOPP gear conducting decon operations and learning TTPs skills.

Contamination Avoidance. It is often said that "an ounce of prevention is worth a pound of cure." Thus, contamination avoidance and protection of the item before a CBRN attack must always be considered during development of TTPs as a mitigation technique for the unit or soldier. Some ways to minimize, prevent, or avoid contamination of equipment include temporary protective shrouds and covers using canvas, plastic sheeting, and shrink-wrap, which can all be quickly treated or discarded safely. These materials must be especially designed to avoid being easily blown off and torn. On the other hand, the item of equipment may also reside protected inside a tent, vehicle, or shelter. Whenever appropriate, these easy field mitigation solutions become part of TTPs to enhance sur-

Figure 3. Soldiers practicing decon operations with a Back-Pack Portable Unit.

vivability of a system in an agent-contaminated environment.

Decontaminants. The TTPs must indicate what decontaminant and exact procedures are appropriate for the system. All fielded decontaminants available to the Soldier are listed in FM 3-11.5; except for DS2, which has been deemed by the Services to be an Army excess item in July 2004. There are other fielded decontaminants still available for use by the Soldier, but there are ongoing efforts to procure updated decon equipment and decon solutions for sensitive equipment, platform interiors, as well as typical platform exteriors. A comprehensive article on emerging decontaminants is available in USANCA's **NBC Report**, Spring/ Summer 2004 issue. That article gives a list of possible candidates for the future decon while the search goes on for a less damaging and less corrosive replacement for DS2. In some instances, existing decon methods in FM 3-11.5 can be altered or modified to enable the Soldier to achieve acceptable decon standards (See Figures 2 and 3). Thus, in the future, a combination of more than one decon might become a possible solution for an item's TTP rather than using only one decon for the entire system. The goal is to achieve a safe level that causes minimal risk hazard to a soldier operating, resupplying or maintaining the system.

Approval of TTPs

The approval of TTPs involves several organizations. In most cases, the CBTDEV, Chemical School Doctrine Division, and Field Artillery School play a role in reviewing the documented decon procedures. These Army agencies determine whether the procedures are adequate for core competency training, and useable by the soldier in the battlefield and by all other military or civilian response teams. To aid in the approval process, those preparing TTPs must also request a thorough review and recommendations from experts in the field such as ATEC-AEC, ARL, DPG, and others who may have operational experience with the system. In all cases, the agency that initially required the TTPs, along with TRADOC and Chemical School, will determine if the proposed TTPs are adequate and sufficient for decon purposes. Before approval, all recommendations from reviewers and approving authorities are given utmost consideration. The approved TTP procedures must be well documented for implementation upon fielding of the system or item. For fielded systems the PM is responsible to develop new fixes and to provide the solution(s) to the end user.

The approved TTPs must become part of a test program and be validated for that system. This approach determines if the TTPs are indeed sufficient and effective to overcome the inability or vulnerability of that system to meet decontaminability. This can be done during the Test Validation Phase. It is equally important that appropriate battle staffs properly integrate the TTPs into the training plans, orders, and staff estimates. After the procedures are proven out, and demonstrated that they work, it is necessary to publish them in appropriate technical or field manuals.

Finally, closure on TTP requirements is reached when the document is fielded along with the system or equipment. The ultimate benefit of having approved TTPs for a system is to give the warfighter a better edge on the battlefield when decon is necessary to continue and accomplish the mission.

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[1] See the DA approved criteria summarized in article "Emerging Decontaminants and Replacement of DS2", USANCA's *NBC Report, Spring/ Summer 2004.*

MAD and the Road to SALT

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MUTUAL ASSURED DESTRUCTION

The theory of Mutually Assured Destruction (MAD) defined for US policy makers the uncontrollable nature of nuclear war and ultimately led to the Strategic Arms Limitation Talks (SALT) with the Soviet Union. The very real possibility of unleashing cataclysmic events of thermonuclear war with unprecedented destruction greatly influenced US nuclear strategy during the Cold War (1960s). Contrary to popular believe, MAD was neither US military doctrine, nor official US policy.[1] MAD, however, was the defining concept for deterring the use of nuclear weapons. It continues today to serve as a reminder to many that "toe to toe nuclear combat with the Ruskies" [2] was insane, irrational and should be avoided at all costs.

In order to examine the influences of MAD and corresponding impacts to US and Soviet policy; this analysis will introduce how theories of war were impacted by the use of nuclear weapons, examine the dynamics of the US/Soviet arms race, and conclude with, that despite criticisms, MAD was the driving factor in introducing arms control as the stabilizing solution to the arms race.

A MAD Beginning

The origin of MAD can be found in the influences of Clausewitz's *On War*. His timeless theories of war define the complex nature between the political and military components of government and their interdependent relationship on one another. As Clausewitz observes, "War is merely the continuation of policy by other means" and there is no better example of a military capability (war) being a true political instrument than the atom bomb. [3] Mere possession of a nuclear capability, no matter how rudimentary can greatly enhance a nation's ability to achieve its political objectives by increasing its bargaining power. The sheer magnitude of "the bomb" and the accompanying threat of apocalyptic destruction serves as a deterrent to those who wish to harm or impose its will over a nation that has acquired nuclear weapon technology. In the current geopolitical atmosphere, North Korea and Iran clearly hold to the idea that nuclear weapon technology is the best defense against western aggression and serves as an effective deterrent to possible invasion by hostile forces.

The military utility of nuclear weapons resides in its ability to directly attack an opponent's will. Paramount to any military strategy is Clausewitz's center of gravity, which may be found in a nation's "armed forces, the country, and the enemy's will." [4] Regardless of the weapon used, the aim of war is to compel the enemy to accept another's will. [5]

Further, nothing short of maximum force will suffice in attainment of war's purpose. Some enemies are more capable and more resolute than others and require greater skills in order to be defeated; such skills may be derived from the employment of certain technologies. Key to any military victory is attacking the enemy's center of gravity with relentless and overwhelming force.

Clearly, nuclear weapons can easily destroy an enemy's army, its cities, and in turn deflate the enemy's will and cause it to sue for peace. With the creation of nuclear weapons and their means of delivery, bypassing the enemy's field army or other obstacles in an attempt to attack a nation's will has become more efficient, less bloody and seemingly easy to those that possess nuclear weapons. As witnessed by the bombings of Hiroshima and Nagasaki, the mass devastation caused by only two atomic bombs demonstrated to the world the all but unlimited power of nuclear weapons and their direct effect on a national will.

Nuclear tipped missiles have compressed the battle space, and have enabled a combatant, with relative ease, to target the military industrial capacity of another nation. Intercontinental Ballistic Missiles (ICBM) can reach any point on the globe within 30 minutes and with amazing accuracy. These unmanned missiles can be easily directed to any military, industrial or geopolitical target.

For decades the US and Soviet Union have relied upon vast arsenals of ICBMs as a replacement for and augmentation to bomber fleets. The flexibility of rapid response, reprogrammable target capability, low maintenance cost and less susceptibility to enemy missile defense systems made ICBMs the weapon of choice. Now more than ever, both sides (US and Soviet) would be vulnerable to the other side's colossal fleet of missiles.

More Recent MAD History

Simply put, the MAD concept outlined for strategists the probable outcome

of a full-scale use of nuclear weapons by two opposing forces. During the height of the Cold War the perception of nuclear exchange between US and Soviet Union was a very real possibility. Adding to the fears of nuclear holocaust were the horrible visions of Hiroshima and Nagasaki survivors. The possibility of surviving something so devastating led people to readily accept death as opposed to living in a world affected by nuclear fallout. Regardless of cause; accidental launch, invasion of Western Europe by Soviet conventional forces (crossing of the Fulda Gap), or rogue military commanders, the perception was that if a single nuclear weapon was launched by one side the other would respond with overwhelming force (massive retaliation).

With the idea of nuclear annihilation in mind, MAD theorized that two rational opposing nations (US and Soviet Union) with near equal nuclear capabilities would not employ nuclear weapons against one another. And therefore, should be considered a de facto deterrent to any form of armed conflict for nations that possess near equal nuclear capability. Deterrence was mutual because both sides possessed a massive retaliatory capability.

The first evidence of mutual deterrence can be found in the book *The Absolute Weapon* by Arnold Wolfers. [6] Even before the Soviets attained nuclear weapons, this Yale professor theorized the conditions of mutual deterrence: "Nothing could be less tempting to a government, provided it were in possession of its senses, than a war of mutual destruction ending in stalemate. It would not be surprising, therefore, if a high degree of Soviet-American 'equality in deterring power' would prove the best guarantee of peace and tend more than anything else to approximate the views and interests of two countries."[7] It wasn't until the increase of Soviet nuclear capabilities (arms race) did the idea of "assured destruction" penetrate US nuclear weapon strategy.

Perceived nuclear disparity, fear of conflict (nuclear or conventional) with the Soviets, rapid nuclear and missile advancements, and the general uneasiness of the 1960s heightened tensions and led to shifts in military and strategic policy. The formal origin of the term "assured destruction" can be found in a series of RAND studies conducted by Colonel Glen Kent. [8] "These studies . . . applied systems analysis methods to evaluate various strategic nuclear postures in terms of American lives saved per dollar spent. For the purpose of these studies, Kent developed two accounting devices which were called 'damage limiting,' and 'assured destruction'." Damage limiting measures included hardening of silos, decoys and civilian protection posturing. Regardless of what was done, the idea of damage limiting could be easily discounted because no matter how many dollars were spent on damage "limiting measures", the technology that was available during the early 1960s yielded minimal results in the number of lives saved. [9]

As with most studies, a rough idea of the study's conclusion was determined even before the study began. As theorized by some, this study was thought to be contrived by then Secretary of Defense McNamara in order to limit the US Air Force's request for thousand of Minuteman missiles. [10] It appears that McNamara realized by the early 1960s the US and Soviet nuclear arsenals possessed enough nuclear weapons with increasing yields and effective means of delivery that each side would suffer beyond what was acceptable (assured destruction).

In McNamara's book, *In Retrospect*, he concludes with "the gravity of nuclear war is extreme, the consequences are dire and mistakes may spiral into uncontrollable and unreversible events with global ramifications." Regardless of the course of action, military leaders could not prevent harm to the civilian population in thermonuclear war. [11] Obviously, the idea of no winners in a nuclear war led some to question the rationality of accumulating more and more nuclear weapons. When was enough, enough? Therefore, the jump from assured destruction to MAD was "based on the observation that, since only a few nuclear weapons delivered on a city could produce vast damage, why buy more than the number needed to assure that?" [12]

A Race for Arms

Fueling the debate of nuclear strategy was the potentially destabilizing arms race. With ever increasing size and number of nuclear weapons (US and Soviet), technological advancements in missile delivery, aircraft and ballistic missile defense, fears of nuclear war, and a perceived missile gap, President Kennedy sought to reappraise US defense strategy. [13] Despite suggestions of increasing civil defense force protection measures, missile defense, and sensible nuclear exchange doctrine (preemption, first attack, massive retaliation, attack on warning, and limited tactical use) McNamara concluded that nuclear weapons were of limited military utility.

> "there would be such severe damage done to this country that our way of life would change, and change in an undesirable direction. Therefore, I would say we had not won. In another sense of the word "win" we would win. We would win in the sense that their way of life would change more than ours because we would destroy a greater percentage of their industrial potential and probably destroy a greater percentage of their population than they destroyed of ours. By "ours" I am speaking of the United States. I suspect that in terms of facilities the amount of industrial destruction in the West would exceed that of the Soviet Union. This is so because you would have to add to the destruction in the United States the probable destruction of Western Europe. My personal opinion is. . . we cannot win a nuclear war, a strategic nuclear war, in the normal meaning of the word "win." [14]

Central to the idea of MAD was the arms race. [15] Any arms race is a dangerous contest of zero-sum game. As one side achieves a technological advantage or a position of numerical superiority the other side simply matches capabilities or adds additional nuclear forces.

Another key ingredient to an arms race is a requirement for both sides to possess significant nuclear destructive capability and reliable delivery methods in order to assure complete destruction of the adversary's country. Simply acquiring several missiles armed with nuclear warheads is not enough to deter the other side or become a bona fide member of the nuclear club.

Also required as a deterrent, was the assumption that if attacked, the receiving nation would respond with overwhelming force. Clearly both sides possessed massive retaliation capabilities necessary to make this perception a reality.

Demonstrated proficiency in nuclear capability (testing) by the Soviets during the late 1950s and the beginning of the 1960s caused the arms race to heat up significantly. Increasing the weapon yields had reached its point of diminishing returns at about 20 megatons. Although the Soviets in 1961 detonated a 60-megaton weapon, which caused great alarm and angered the Kennedy administration, the effects of that detonation weren't that much greater than a 20-megaton weapon. [16]

Advancements in nuclear weapon technologies now began to focus on improvements to delivery system efficiency and effectiveness, and aircraft and ballistic missile defense. The appeal of missile defense was promising, however, in the end; senior civilian leadership at the Department of Defense concluded that the dynamics of mass raid, Multiple Independently Targeted Re-Entry Vehicle (MIRV), decoys/penetration aids and the sheer number of Soviet missiles would overwhelm any missile defense system. [17] Other arguments against missile defense were; difficultly in justifying high R&D expense while in an environment of fiscally constrained resources, and, most importantly, perceptions that missile defense systems had the potential for destabilizing the arms race.

In the end, the realization that however hard both sides worked, their increases in nuclear forces and advances in technology came without giving either side military superiority. Seasoned with lessons learned from the Cuban missile crisis, it was the US that first recognized the danger in continuing the nuclear arms race.

Controlling Arms

A shift in US policy from a threat of massive retaliation towards arms control occurred shortly after the Cuban missile crisis. "Based on the experience of the Cuban missile crisis, Kennedy recognized the unacceptability of a national military strategy over dependent upon nuclear weapons." [18] A moderate move towards arms control while still retaining the flexibility of nuclear weapon use and increasing conventional forces was seen as a logical approach to slow the arms race. The possibility of arms control was probable because both the US and Soviet Union had a "mutual interest in the avoidance of a war that neither side wants, in minimizing the costs and risks of the arms competition and in curtailing the scope of violence of war in the event it occurs." [19]

While the logic of MAD indirectly impacted US policy, the Soviets continued to race forward with the belief that victory in nuclear warfare was attainable, which was due in part to their confidence in their retaliatory strike force capabilities.

Rejecting the ideas of MAD, the "Soviet approach to nuclear warfare as 'war fighting' to win, in comparison with the US approach of 'deterrence' via the threat of mutual assured destruction." [20] Soviet leadership didn't believe the MAD theory because of military uncertainties. "This is because there was no guarantee in practice that a retaliatory strike would be launched or inflict unacceptable damage on the enemy." [21] The foregone conclusion made by some is that the theory of MAD wasn't relevant because the Soviets questioned the probability of America's ability to retaliate. Therefore it could be inferred that the Soviet view was assured destruction wasn't mutual at all. This line of reasoning, when taking the Soviets' statements at face value seems to be correct. However, upon scrutinizing actions by the Soviets, the conclusion is that the Soviet leadership also rejected the idea that nuclear confrontation with the US was winnable or worth the likely risk.

The Soviets' public rejection of MAD was suspect given their willingness to enter into treaties with the US. Language found in the treaty banning nuclear weapons tests in the atmosphere, outer space, and under water of 1963 is a clear indication that the Soviet Union was interested in ending the arms race. In part, the treaty states its principal aim is to achieve an agreement "which would put an end to the armaments race and eliminate the incentive to the production and testing of all kinds of weapons, including nuclear weapons." [22] If this isn't enough evidence of Soviet commitment to ending the arms race, the Treaty on the Non-Proliferation of Nuclear Weapons of 1968 contains strong language warning against proliferation of nuclear weapons. "Considering the devastation that would be visited upon all mankind by a nuclear war and the consequent need to make every effort to avert the danger of such a war and to take measures to safeguard the security of peoples." Entering into these treaties and other agreements (Hot Line, 1963) is clear evidence that the Soviet Union was warming up to the idea of nuclear balance and the necessity of maintaining the status quo of missile inventory and technological achievements.

On September, 18, 1967, the US announced that it would begin deployment of a "thin" antiballistic missile (ABM) system. [23] With the Soviets vastly overestimating our ABM capability, (which was only introduced as a solution to a possible Chinese ICBM attack) the Soviets were motivated to try and negotiate in order to limit our perceived advantage. [24] The Soviets saw SALT as an opportunity to stop or limit the arms competition

while they retained the lead.

Of course, by this time the US was already willing to enter into cooperative agreements with the Soviets because of the illogical notion of spending large amounts of money to produce capabilities that would be superseded by future Soviet expenditures – all in the sake of producing or developing more capabilities that weren't necessary to begin with. Gerard Smith, former ACDA Director and chief SALT I negotiator, intelligently observed, "The strategic competition was not unlike a game of tic tac toe. If one knows how to play it and makes no mistakes, one cannot lose. And if both sides know how to play it, and make no mistakes, neither can win." [25] The US realized that SALT represented an opportunity to end the seemingly endless cycle of aggrandizing nuclear weapons and missiles.

The salient points of SALT were the limitation on growth of strategic offensive forces and the agreement to set low limits for ballistic missile defenses. When commenting on SALT during an interview, former Secretary of Defense, Dr. Harold Brown, observed "In particular, both sides agreed not to mount a nationwide defense that might be capable of preventing a strategic ballistic missile attack from succeeding. In that sense, both sides accepted the idea of mutual assured destruction, and I think that was perhaps the greatest achievement of the SALT discussions." [26]

CONCLUSION

With the benefit of hindsight, MAD has been heavily criticized for its shortcomings. For example, the theory of MAD has been labeled morally repugnant, lacked Soviet acceptance - therefore not mutual, wasn't a deterrent, and innocent civilians were unnecessarily placed at risk. However, as examined, the common perceptions of people during the height of the Cold War (mid 1960s) leads one to understand why events transpired as they did. Nuclear Armageddon was the driving force that ultimately led to arms control agreements. The concept of MAD was a reality to political and military strategists of the 1960s and early 70s on both sides of the nuclear divide.

Heavily influenced by the Cuban Missile Crisis, US and Soviet leaders witnessed first hand the potential disasters of nuclear war. Fortunately, both Kennedy and Khrushchev (and future Soviet and US leaders) chose wisely when dealing with this crisis and other conflicts during times of heightened tensions. The greatest benefit to all of mankind is the realization that the only solution to the US/ Soviet arms race was cooperative agreements. The acceptance of MAD and the ensuing Strategic Arms Limitation Talks signaled an evolution of policy that tipped the scales toward arms control and away from nuclear weapon centered strategy.

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ENDNOTES

1 Charles J. Fairbanks, Jr. "MAD and US Strategy," in Getting MAD: Nuclear Mutual Assured Destruction, Its Origins and Practice, ed. Henry D. Sokolski (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2004), p. 137.

[2] Taken from a quote by Major T.J. "King" Kong, aka Slim Pickens in the movie Dr Strangelove: or How I Stopped Worrying and Learned to Love the Bomb.

[3] Carl Von Clausewitz, On War ed and translated by Michael Howard and Peter Paret (Princeton, New Jersey: Princeton University Press, 1984), p. 87.

[4] Ibid. p. 90.

[5] Ibid. p. 75.

[6] Michael Krepon, Strategic Stalemate: Nuclear Weapons & Arms Control in American Politics (New York: St. Martin's Press, Inc., 1984), p. 38.

[7] Ibid

[8] Fairbanks. Op. Cit. p. 144. "What dampened enthusiasm for non-MAD strategic postures even further were a series of RAND studies done by Colonel (later General) Glen Kent in the Pentagon's deputy directorate of Defense Research and Engineering (DDR&E). These studies were published from July 1963 to January 1964."

[9] Ibid. "Pentagon official were frustrated in their efforts to justify spending on damage limiting measures. Each measure suggested was very expensive and produced improvements that were not very grand. Starting in Fiscal Year 1965, tables printed in the Defense Department's annual posture statements showed that, for each large increase of expenditure, the projected number of lives saved increased. The problem was the number of lives saved was unimpressive against the enormous projected number of casualties the United States would suffer even with the most expensive damage limiting capability in place."

[10] Henry S. Rowen. Introduction to Getting MAD: Nuclear Mutual Assured Destruction, Its Origins and Practice, ed. Henry D. Sokolski (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2004) p. 4. Also Doctor Gideon wrote in a personal email to the author "MAD was a creation of Robert Strange McNamara; and, it was devised to justify his cuts in nuclear forces."

[11] Available online at http://www.gwu.edu/^nsarchiv/coldwar/interviews/episode-12/brown3.html. Taken from an interview with Former Secretary of Defense, Dr. Harold Brown. "The thought that, no matter what you did to build up your military forces – conventional or strategic – your population, your nation was at risk of destruction anyway, because if the Soviets were crazy enough to launch a nuclear attack or to launch a conventional attack that escalated to a nuclear attack, it would end up in mutual destruction through strategic thermonuclear war – that was disconcerting to the US military leadership, as it was also to the Soviet military leadership. After all, the first function, primary function, of a military force and a military leadership is to preserve the physical nature of their country; and in a thermonuclear world

they cannot give that assurance, no matter what they do."

[12] Rowen. Op Cit. p. 4.

[13] William W. Kaufmann, The McNamara Strategy (New York: Harper & Row, Publishers, 1964), p. 47. President Kennedy's State of the Union Address early 1961. "We are moving into a period of uncertain risk and great commitment in which both the military and diplomatic possibilities require a Free World force so powerful as to make any aggression clearly futile. Yet in the past, lack of a consistent, coherent military strategy, the absence of basic assumptions about our national requirements and the faulty estimates and duplication arising from inter-service rivalries have all made it difficult to assess accurately how adequate-or inadequate-our defenses really are."

[14] Ibid. p. 95.

[15] Rowen. Op. Cit. p. 6.

[16] Available online at http://www.gwu.edu/^nsarchiv/coldwar/interviews/episode-12/brown3.html. Taken from an interview with Former Secretary of Defense, Dr. Harold Brown.

[17] Ibid.

[18] David P. Kirby, "Strategic Defense and Security," in Essays on Strategy, (Washington DC: National Defense University Press, 1988) p. 118.

[19] Krepon. Op. Cit p. 9.

[20] John A. Battilega, "Soviet Views of Nuclear Warfare: The Post-Cold War Interviews," in Getting MAD: Nuclear Mutual Assured Destruction, Its Origins and Practice, ed. Henry D. Sokolski (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2004). This article represents a summation of the Hines Report. From 1989-94 a team of American Soviet specialists conducted personal interviews in Moscow with former Soviet officials, which included high ranking military officers, which was led by Robert Hines.

[21] Ibid p. 160.

[22] J.A.S. Grenville and Wasserstein, The Major International Treaties Since 1945. A history and Guide with Text (London: Methuen & Co. Ltd, 1987) p. 442.

[23] Available online at http://www.state.gov/www/global/arms/treaties/salt1.html.

[24] Available online at http://www.gwu.edu/~nsarchiv/coldwar/interviews/episode-12/brown3.html

[25] Krepon. Op. Cit. p. 39.

[26] Interview is available online at http://www.gwu.edu/~nsarchiv/coldwar/interviews/episode-12/brown3.html

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Lest We Forget

Rick Barker
NBC International Summer 2006

The Spanish philosopher George Santayana is widely quoted as saying that those who ignore the lessons of history are condemned to repeating them. Today successful organisations in the private sector and the public domain heed this adage and put systems in place to eliminate the duplication of costly mistakes.

As the term NBC gives way to CBRN and first responders join militaries in assuming key roles in defending against these weapons of mass destruction, the time is opportune to look back into history to see what worked, what did not and how defences were developed and adjusted. Modern militaries have formal programmes to record positive and negative lessons, develop strategies to take advantage of them and track the success of their implementations. The lessons learned process is an integral part of pre-mission planning and post-mission analysis, particularly in the current context of dangerous peace enforcement missions.

Apart from relatively minor combats like the Iran-Iraq war, chemical warfare has been largely absent from battlefields since World War I. Nuclear and biological warfare have been even less evident, except for the two nuclear bombings in the spring of 1945. But adversaries in World War II and later conflicts were prepared to engage in chemical warfare. A number of reasons prevented them from doing so, one of the most important being the quality of protective devices.

Modern planning staff working in NBC defence might be forgiven for failing to examine the conduct of the chemical attacks of the 1914-1918 period. The early development stages of the chemicals, and the fact that the attacks were directed against relatively static and highly concentrated adversaries, can easily lead military and first responder staff to mistakenly conclude that lessons from that era do not apply to the asymmetric threats that we face today.

Much has been written about the chemical warfare component of World War I and it tends to focus more on the offensive aspect than on the defensive. Historians see World War I as the watershed of combat: it started in 1914 in a manner not dissimilar to the Napoleonic wars of a century before, and finished as a precursor to the more modern, all-arms conflict of World War II.

Once strategy, tactics and technology had solved the stalemate of two well-armed adversaries firmly entrenched just metres apart, the concept of joint all-arms military became reality. It would have many components, each with their particular strengths and weaknesses, leaving commanders to choose which to employ, and where, to maximise the chance of success.

Chemical warfare fits well into this concept. At first it was an end unto itself and later grew into a weapon that was used effectively as an enabler for other weapons and tactics, especially the reduction of enemy morale. The first attacks at Ypres in the spring of 1915 are good examples of the use of chemicals in independent fashion. Although they did create a gap in the allied line, there was no follow-up to exploit this weakness and adjacent forces moved quickly to plug the hole.

Later in the war, chemicals were used to eliminate gun batteries that were largely invulnerable to shelling and pave the way for infantry to advance on foot. Other applications included the severing of the rear lines of communication and disruption of the progress of reserve forces. When used in this way, chemical attacks were carefully co-ordinated in time and space, the fire plan, and the overall assault scheme.

At first glance, these descriptions lead one to question how lessons from chemical warfare could apply to the use of NBC agents by a furtive, small-scale, asymmetric adversary. From a somewhat narrow perspective, that feeling might be understandable but from viewpoints of science, technology and even meteorology, there is much to be learned.

Successful comedians will tell you that they can get a laugh or two from breaking a chair over a stooge's head but that they will have a much stronger and more prolonged reaction from the audience by bending a chair over his head. The enduring vision of the bent chair serves to prolong the humour. This is analogous to the long-term effects of NBC attacks, where a combatant might be killed by a bullet or shell with attendant effects on morale, national support and logistic burden but gas can have a much more pervasive and long-lasting effect.

While gas certainly has the capacity to kill, it can also impose extended suffering and, like the bent chair, serve as a constant reminder of what has occurred. NBC contamination can deny the use of terrain to militaries and civilians for extended periods, it can put victims into lengthy medical treatment at great financial cost, it may cause suffering for friends and family, and the prospect of its repetition can erode the national will to continue the fight.

To avoid these plights, we need not just a suite of protective devices but rather a well-thought-out system of defence. Modern gas masks offer protection well above what is considered the minimum necessary against

classical NBC agents and a selection of toxic industrial materials (TIMs). Unbroken skin is an effective barrier to some chemicals as well as most biological and radiological substances.

The drawbacks are that gas masks are not suitable for continuous wear and that the rest of the body still needs protection against blistering and nerve agents as a minimum, and body suits impose a significant thermal and fatigue burden on the wearer. While combatants have good reason to be confident in their individual protection, they want to minimise the time that they spend "cocooned".

There is a requirement for a broader protective system; we need to have the protective devices but also the means to restrict the wearing of them to essential periods. Such a system begins with counter-proliferation efforts, and progresses through pre-mission assessments, the intelligence preparation of the battle space and the installation of effective warning measures to efficient decontamination systems. A counter-proliferation mechanism was in place before 1914 via The Hague Convention of 1899 to prohibit the use of chemical warfare, but its wording was overly specific and left a technical loophole. To be effective, agreements and treaties must be crafted carefully to deny all means of use and be supported by inspection regimes to validate national compliance or alert signatories to breaches.

The advance parties for any mission bear the responsibility for surveying the operating area for potential hazards. They also select encampments with due consideration for the vulnerability to intentional and unintentional releases of contaminants. This involves assessing possible industrial sources of hazards, determining prevailing local weather conditions and taking advantage of natural defences and terrain. The advantages of high ground are important in NBC combat as they are in conventional warfare. If forces in World War I been able to select their battlegrounds with this consideration it is likely that many casualties would have been averted.

History records that allied intelligence services had reported evidence of preparations for chemical attacks in the days leading up to the first use at Ypres. With the advantage of hindsight, we can imagine the great amount of suffering that could have been avoided had the allies acted upon that information. In the modern context, intelligence remains as crucial, but it is also critical to ensure that operational staff and their commanders fully understand the implications of NBC intelligence and the techniques for countering the threat. To be able to take full advantage of NBC intelligence requires thorough training at all levels as well as the availability of effective decision aids. This can best be achieved by ensuring that exercises from sub-unit to national levels involve NBC inputs, decisions, and actions. The attitude "NBC – a way to ruin a good exercise" can no longer be tolerated.

The earliest attempts to shield individuals from the effects of gas were rudimentary at best. Initially they consisted of advising soldiers to breathe through urine-soaked cloth. This was followed by supplying gauze pads that provided a modicum of protection until they became wet, when they blocked the passage of air and suffocated the user. Ultimately, troops of both sides were equipped with precursors of modern gas masks, but the breathing resistance and visual restrictions that they imposed made the soldiers less efficient and more vulnerable to other battlefield hazards.

Ninety years later, the NBC industry is still trying to reduce breathing resistance and the thermal and fatigue burdens of individual personal protection. As a complementary measure, comprehensive systems of NBC defence are being developed and fielded comprising detection, identification and monitoring; warning and reporting; physical protection; hazard management; and medical counter-measures and support.

By establishing this system-of-systems, forces maximise the time that their personnel can operate without being encumbered with personal protective devices. Yet one of the principal effects of gas attacks in World War I was the effect on morale. Once troops had witnessed the horrors of gassing and after having undergone the training regimens, they were fully cognisant of what they faced to the point of almost complete preoccupation. Fears of inadequacies of protective equipment coupled with frequent gas alarms conspired to erode their morale and increase their fatigue. To counter this factor, troops must be infused with confidence firstly in the reliability of masks and clothing to shield them from the egregious effects of the agents and also in the system's overall ability to warn them in sufficient time for troops to don protective equipment.

The ultimate confidence booster is witnessing the passage of contamination through an operating area with no adverse effects on personnel or equipment but this tends to come a little late for most users. Testing personnel's masks against simulated or real agents goes a long way to instilling confidence; although care must be taken to ensure the fidelity of the simulants so that false confidence is not encouraged. An aggressive information distribution programme (posters, brochures, training films, etc) serves as an effective adjunct to gas hut exercises.

The great quantities of gas used in the attacks of World War I often saturated the gas masks in use, rendering them useless and frequently prompting wearers to remove them. At the same time, it was recognised that masks needed to be removed from any chance of collecting dirt and dust when not in use. We do not face such massive attacks today but the requirement for mask care remains paramount and the issue of filter life prevails. The R&D community should be strongly encouraged to pursue promising technologies in providing service life indicators for gas masks.

Weather, particularly wind direction and speed, was a primary factor in the use of chemical weapons and merits serious consideration in defence planning. World War I users

found that stiff winds tended to limit the effects of gas attacks through higher dispersion and narrower contamination footprints. Conversely, light and variable winds often caused the gas to return to the point of origin and affect friendly forces.

A common mistake today is to base camp sitings solely on prevailing winds. Meteorological services can supply "wind roses" that indicate the most common wind directions. Planners, however, must allow for seasonal, diurnal, and frontal variations. Concentrating point sensors on the normal upwind approach to an area is fine until the wind shifts, at which point the formation must have the ability to rapidly adjust the placements. A more sensible plan is to have all contingencies covered.

Experience in World War I showed that the ideal wind speeds to derive the maximum benefit from a gas release were between five and 15 mph (8-24 kph). When intelligence reports point to a heightened risk of attack, NBC staff should monitor wind speeds and consider recommending increased readiness levels when winds approach this range. Between sunset and sunrise winds often become light and variable due to low-level atmospheric inversion caused by radiation cooling. This becomes particularly important if a release occurs within a protected area. There must be sensors placed well within the perimeter to detect an omni-directional spread of contaminants.

Weather has its good side too. Rain and cold have generally disabling effects on chemical and biological NBC hazards. The attendant danger, however, is that when the weather improves the dangers can reappear. In other effects, wind tends to disperse contaminants while sun and time often reduce their toxicity.

Like any other technical aspect of warfare, the offensive and defensive aspects of NBC have played leapfrog since 1915. No sooner was a counter-measure developed than a new threat appeared. This situation prevails today and operational and R&D staff must remain vigilant to new developments, both technical and procedural. Binary releases, phased releases, and attacks combined with other weaponry can confuse defences and render them unprepared for deadly secondary assaults.

The soldiers who first were faced with gas in World War I did not have the benefit of experience or training in protecting themselves. Some chose to run away from the approaching clouds only to be overtaken and overcome, rather than running upwind towards the cloud and minimising the time spent within it. Modern NBC defence courses need to teach this and similar basic NBC survival lessons.

Sometimes a little knowledge can be dangerous. In the face of an approaching cloud, a soldier might reason that it is heavier than air and attempt escape by climbing. But if there is any degree of atmospheric instability the contamination is likely to extend to any height that a fugitive is likely to scale due to the nature of cloud density. At the same time, climbing normally removes the soldier from protective ground cover and renders him more liable to conventional attacks but descent is sure to bring disaster.

There were occasions when one side had the opportunity to employ chemical weapons but demurred, apparently lacking confidence in the ability of the gas to have a significant impact in the face of the defenders' protective equipment. This factor is cited as a possible reason that NBC attacks did not occur in the first Gulf War and even in World War II. The same sort of information programme used to instil confidence in the protective equipment can be extended to potential perpetrators to discourage them from using contaminants.

The threat of a gas attack had greater effect when combined with a lack of confidence in protective equipment. Troops tended to dwell on the ever-present danger, lowering their morale, losing sleep and incurring fatigue from wearing gas masks and other protection almost constantly. This gradual wearing down was a major factor in the overall effectiveness of chemical weapons and underlines the need for an efficient NBC defensive system, confidence in equipment, and thorough training.

The use of NBC weapons in an asymmetric attack is almost certain to be on a much smaller scale than was witnessed in World War I and for somewhat different purposes. Attacks are unlikely to be accompanied by follow-on offences and not intended to inflict mass casualties. What they would have in common is an attempt to shape the conflict and, more importantly, erode morale in the mission and at home. Here, the counter-measure has not changed – an effective system of defence coupled with a broadly applied information programme should prevent adversaries from gaining the upper hand.

During World War I, both sides made much progress in chemical warfare and chemical defence. Today, the details have changed but the underlying principles of defence remain essentially unchanged. The lessons learned from both the attacks and their counter-measures provide valuable tools and checklists for modern NBC defence planners. Those of us who choose to ignore these lessons are condemned to repeating them.

NBC International Summer 2006
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At Home On The Range

Mr. Gwyn Winfield

NBC International visits Porton Down's "range" to look at the work that Defence Science and Technology Laboratory is doing on demilitarization

Those aspirant scholars of British chemical warfare prowess would do well to visit "the range" at Porton Down. This area was at the cutting edge of British prowess in delivering offensive CWA during the 1950s. Shells would pour down from the Iron Age fort at Figsbury, just outside Salisbury, onto the "bowl", or some of the hard target sites around it, at Porton and scientists would examine how well the burster, or ejector, munitions worked and what the spread of agent was likely to be. It is fitting then that the range is now the home of the UK's chemical demilitarisation project. Unlike the US and Russia, which have far larger and more varied arsenals, the UK's is a more... parochial affair.

The UK never had the stocks of nerve agent held by the two major Cold War adversaries, and neither did they keep them so long. With the exception of the minute amounts allowed under the Chemicals Weapon Convention (CWC) for improving NBC defence, the UK disposed of all its chemical weapons in the 1950s, which was a much less sophisticated time for such an event. Free from things like Health and Safety and EU Environmental Guidelines, the 1950s saw a jamboree of chemical weapons disposal; some went into the oceans (dilution being the solution to pollution) to be picked up by trawler nets, some went into poorly marked pits to be found when digging bunkers on golf courses, and the majority was incinerated.

The big round-up

The (CWC) has no such approach to demilitarisation; each munition must be tagged, with documented proof given of its final demise. Signatory countries to the CWC have until 2007 to clear their stocks, but it is widely expected that this will be extended – at least for the US and Russia that have immense stocks of these munitions still to be safely destroyed. The UK and Germany fit into a second tier of countries that have a historical legacy of these weapons – other countries that have a First World War legacy of these munitions, such as Belgium or France, are not covered as the Convention includes only post-1925 munitions.

The majority of the 200-300 finds that the UK has to destroy each year comes either from the ranges where these weapons were used or developed (such as Winterbourne Gunner), or from (stretching an allusion) "orphaned sources" meant to be destroyed but lost either in the 1950s Ministry of Defence (MoD) bureaucracy or misplaced in the UK. The majority are mustard, of varying quality, but occasionally phosgene and BBC (Bromo Benzyle Cyanide – a less lethal version of hydrogen cyanide) turn up as well. The UK's approach to the destruction of these agents is commensurate with the amount and virulence of the agent; the majority are incinerated at 1,000 degrees C, though some are now going through a process of hydrolosis.

Richard Soilleux, Technical Leader for Defence Science and Technology Laboratory (DSTL) demilitarisation program, described the procedure: "When we receive a munition, it has already been examined by a military EOD team who has decided that it is explosively safe to move". "Once they have done that we send our experts up to assess whether or not it is a chemical munition. It is then packed into suitable sealed containment – so that if there is an accident we know it won't be spilled all over the public highway – and it all goes in convoy. Once it arrives at Porton Down it goes into storage, is given a unique tag and is then x-rayed, which is done at a 45 degree angle so we can see the liquid – this also allows us to see the fusing mechanism and whether there has been any corrosion or decay there."

"Once we know it is chemical, we take it for further examination by PINS (Portable Isotopic Neutron Spectroscopy), which uses thermalised neutrons to penetrate the munition where they react with the nuclide acids in the shell and give a gamma spectrum. This gamma spectrum has characteristics of the matter it reacts with, so we look for signature atoms such as chlorine or sulphur, both of which are found in mustard – the software then analyses these spectra and says we have chemical agent and it is likely to be mustard. It gives us a good indication, but it is not foolproof because you can have mixtures that can confuse it, or small munitions with small quantities of agent. It is very good for high explosive (HE) and white phosphorous; those two things are rather dangerous and we wouldn't want to put them thorough our processing system – so it is good screening method to remove the hazardous items to allow us to concentrate on the chemical items."

As Dr. Soilleux remarked, PINS does allow a certain amount of knowledge to be gleaned from a closed container, but it still requires skilled operators to run it. Some of the telltale elements that you would be looking for are also found in benign substances – such as sea water.

Live Excavation

The latter is not as esoteric a conclusion as one might think, as sea water was used in test shells because it was deemed to have the same density as mustard – allowing spread patterns to be judged with a safe liquid. At the various testing grounds where these trials took place, these test shells are not uncommon; it requires a precise understanding of the spectra to appreciate what is likely to be mustard and what is likely to be sea water.

Whatever the chemical payload, most of the shells have a small explosive device to disperse the agent over a wide area. In later devices these were small explosive rods in the centre of the munition that would split the canister in a useful manner while incinerating as small a proportion of the agent as possible – some US manufactured shells that turn up in the UK are pressurised as well (as are some UK shells that have had a secondary chemical reaction inside the shell) which poses additional problems.

"The chemical munitions usually only have relatively small explosive bursters," said Richard Soilleux, "so it is a lot safer to deal with those than conventional munitions, explosively speaking; chemically it is a different matter. If that is the case then we will drill them to take a sample and send that to a lab for definitive analysis. Once we have done that, we can decide on a disposal method. If it is phosgene, we will drill it out and neutralise it; if it mustard or BBC it goes to the incinerator, which is straightforward and gives good results. We are developing a hydrolysis method as a fallback. Having done that, we need to treat the shells before we can release them for scrap – which we do in an incinerator – we have far less environmental restrictions on that as the contamination is only residual."

The hydrolysis method is a new procedure that the range team are developing. While it has been used in the past by the US, for example, the smaller quantities in the UK make incineration an easier and more cost effective, solution. "Basically, our demilitarisation method is incineration," said Dr Soilleux. "Mustard burns very well – it burns like diesel, and with our pollution abatement system we can get very good clean-up rates. We don't have any Crown immunity; we have to meet all the environmental guidelines, we are regularly inspected by the Environment Agency and we have to meet all the statutory requirements. It is a very good way of dealing with mustard, we didn't talk about phosgene, because it is a lesser

problem, but when we do find it we drill the munition and pump it into sodium hydroxide at the facility and that neutralises it."

"We decided to develop hydrolysis as a second string to our bow. We had reliability problems with the incinerator – it is getting older – and we were looking for a replacement. After 2007 we are going to have to come up with another solution for these old munitions, so we are studying that now – and it may or may not involve an incinerator. Because we have these reliability problems, and because we wanted to make sure we were compliant with CWC, we came up with another method which is hot water hydrolysis. We then neutralise it with some bacteria – otherwise we'd end up with thiodiglycol, which is controlled as a schedule two compound under the CWC as it is one of the base chemicals of mustard."

Working with the natives

In an example of "nature will find a way", the bacteria that Porton Down uses to break down thiodiglycol is naturally occurring. The range is now working closely with Oxford University to come up with a natural chain reaction that will render mustard completely harmless. "We found that there were one or two sites where there were residual elements in the soil from the disposal efforts in the 1950s – which wouldn't meet modern standards but were deemed fine for the day. We revisited these sites and we, together with Oxford University, found that the normal soil bacteria had adapted and had become much more tolerant to mustard and could work in that environment much better than normal bacteria. Normal bacteria will break it down eventually, but these bacteria are just more efficient because they have decided to use the elements found in mustard. We are planning to use some of those bugs to destroy our thiodiglycol, and some of the other by-products of the hydrolysis of the mustard. All we are doing is speeding up a naturally occurring process – there is not one super bug that deals with it; it is a whole family, or consortia, of bugs. One of them will take thiodiglycol down to an acid and another will take it down to another stage, so each one makes a waste product that the next one eats. They all support themselves in other ways too, feeding nutrients into the others to take advantage of this food source and eventually they will reduce it to an innocuous sulphate."

While it may end up an innocuous sulphate, this mustard is anything but innocuous when it is brought up. While mustard degrades and can polymerise – turning into a rubber-like substance – part of the agent remains as deadly as it was when it was first created. Richard Soilleux explained, "The problem with mustard is that even though it does polymerise – which accelerates as it comes up to the surface and is likely to be something to do with the rapid change in temperature from day to night – it is variable. The ones from Woburn Golf Course, for example, were in very good condition – it also depends on how pure it was to start with – so we brought them up in absolutely beautiful condition, they were well stored and there is nothing to say that in 50 year's time they wouldn't be as lethal as they are now. It is a long term problem."

While there may be some clues from their location as to what their likely state might be – those that were fired at a target are likely, due to impact, to be in a worse state than those that were buried intact – it is often not until the team is able to extract a sample that they have a clear idea of what they are dealing with. Due to the bursters running the length of the munition, often it is not practical to saw the top off, as is done with base eject munitions, and the team have to drill the munition, either to take a sample or drain it completely. Previously they had relied on a large, static, industrial drill to do this, but now the team are using the Monica system, which allows them to take the drill to the munition – especially useful for any munitions that need to be drilled in the field.

Dr Soilleux admitted that the system is not as sophisticated as the US version, but pointed to the fact that it is easy to maintain (all maintenance is done on site by members of the team), train people on and is, most importantly, safe. All operations are done remotely, ensuring that the operator is protected, and that by adhering to the filtered negative pressure working environment (and the stringent Environmental Agency regulations) that the system is clean – the public and staff are never at risk. The site focusses strongly on history – the team need to be able to differentiate between 12 versions of a four-inch mortar shell, for example, and is soon likely to be history itself.

There is currently no provision for legacy chemical munitions after the end of the CWC in 2007 and, while this is a problem that will lessen as all the low hanging fruit (such as the 1,000 odd shells that were recovered from Winterbourne Gunner) are destroyed, it will never completely disappear, as finds will appear over time that will need to be dealt with. While the range is not prohibitively expensive to run, unlike the US and Russian systems, there is a cost attached to it in terms of training and staffing that the MoD would no doubt like to minimise. There is already a touch of nostalgia from staff, who have clear enthusiasm for this unpalatable job, over what will happen to the range post-2007 when much of the work will dry up. While the OPCW deliberates over what will be the fate of nations like the UK post-2007, the final testaments to Britain's CWA past are being fed into the incinerator and this page of warfare slowly erased.

NBC International Summer 2006
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Missile Defense Battle Tracking

MAJ Drew Pache

For the past year and a half, I attended several exercises as a CWMD subject matter expert with a team from one of the Army's foremost training programs (due to attribution concerns the group will remain un-named). The team is organized by doctrinal warfighting function and serves in an observer/trainer role for the unit being exercised. Combating weapons of mass destruction (CWMD) falls under the Protection function along with air and missile defense (AMD), NBC passive defense, EOD, and provost marshal, and the majority of focus for this element is in the rear area, now doctrinally referred to as part of the Joint Security Area (JSA). One thing I've seen at every single exercise deserves note because of its potential impact on military operations and civilians in the JSA.

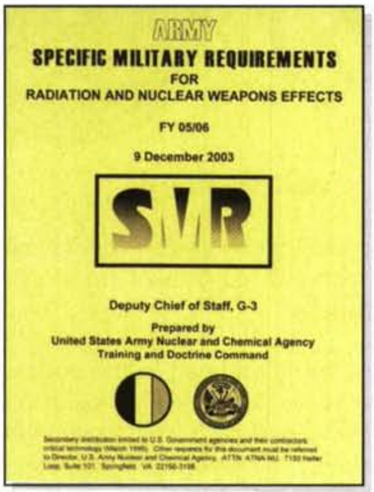
Two things generally happen when US forces detect an inbound enemy missile. If not headed towards a facility on the Defended Asset List (DAL), the missile is not usually engaged. This incoming missile lands somewhere and presumably explodes. The second situation has the missile being engaged and destroyed. This is good news, except that the pieces fall back to earth and depending on where the incoming missile was hit, the warhead could still be intact. This was made painfully evident during the Gulf War when 28 reservists were killed when the remnants of a "killed" Scud exploded in the warehouse they were using as a temporary barracks. The Protection staffs that I observed did not have workable TTP's in place to track these hits or to get any timely battle damage assessment (BDA) at the impact site. This doesn't mean that the information is not available. The likely impact zone for all missiles is determined but the AMD staff and is shown on the Common Operating Picture (COP) network. However, if the zone does not contain friendly troops and is outside an area on the DAL, the launch is ignored and not followed up on.

These impacts can have substantial effects on the civilian infrastructure and populations, which in turn can translate into problems for the ground forces in the JSA. Conventional warheads are bad enough, but the problems multiply if the warhead is other than conventional. Chemical and biological munitions not only produce effects in the immediate area, but also produce a hazard downwind of the strike. This plume can extend into populated areas, troop concentrations or across main supply routes (MSR) and can last for days or weeks. This hazard exists regardless of whether the missile gets intercepted or not. The chemical fill may actually be more effectively dispersed over a wider area if the warhead is destroyed in flight. A secondary but no less disruptive effect of these attacks is the induced terror in the civilian population. A population in panic will hamper first responders and large scale evacuations, whether warranted or not, will clog busy MSR's. This effect may have more impact on operations than the strikes themselves. Clearly, situational awareness of these impacts and their effects are crucial to any battle tracking effort yet it is being largely ignored by operational level staffs.

An assumption is this problem exists in "exercise world" and would be dealt with more effectively during real world operations. However, the TTPs and battledrills that a staff operates with are developed during these exercises, and if no method of tracking and disseminating this information exists during peacetime, the first few events will come as unpleasant surprises after the shooting starts for real. The responsibility for tracking missile strikes in the JSA should reside with the Protection Cell, specifically within the AMD section. Unless the errant missile falls on or near a friendly unit, host nation civilians, law enforcement or other first responders will be the first on the scene. Both the BDA and the type of warhead need to be determined as quickly as possible to gauge potential impact on operations, and this information should flow from the responders through the host nation military to our Protection Cell. This information should be briefed to the Joint Task Force (JTF) commander during the Battle Update Brief in addition to the number of missiles launched and number intercepted (usually the only info on the briefing slides). Sometimes it may not be possible to get this information in a timely manner for any number of reasons, but procedures need to be in place to track these strikes the best we can.

I have not seen every staff in the Army and there may be some out there that are doing an excellent job tracking any and all missile strikes in the JSA. Bravo to those that are. To those that are not, however, I hope that by pointing out this issue we can all put our heads together and come up with a solution that best fits each command's varying operational environment.

Combating WMD Resource Page


ARMY

SPECIFIC MILITARY REQUIREMENTS
FOR
RADIATION AND NUCLEAR WEAPONS EFFECTS

FY 05/06

9 December 2003

SMR

Deputy Chief of Staff, G-3

Prepared by
United States Army Nuclear and Chemical Agency
Training and Doctrine Command

Specific Military Requirements (SMR)

The FY 08/09 SMR preparation process has been temporarily halted. JRO now has the responsibility for assembling all Service NWE requirements. USANCA continues to wait for JRO guidance.

Related 2007 Technical Meetings

26th Hardened Electronics and Radiation Technology (HEART) Conference 31 March-4 April 2008
2008 DoD E3 Program Review TBD 2008
2008 IEEE Nuclear and Space Radiation Conference (NSREC) TBD 2008

POC is Mr. Robert Pfeffer @ 703-806-7862

FA52 Courses of Interest

Theater Nuclear Operations Course (TNOC)

TNOC is the only course offered by a Department of Defense (DOD) organization that provides training for planners, support staff, targeteers, and staff nuclear planners for joint operations and targeting. The course provides overview of nuclear weapon design, capabilities and effects as well as U.S. nuclear policy, and joint nuclear doctrine. TNOC meets U.S. Army qualification requirements for the additional skill identifier 5H. The course number is DNWS-RO13 (TNOC). Call DNWS at (505) 846-5666 or DSN 246-5666 for quotas and registration information.

Nuclear and Counterproliferation Officer Course (NCP52)

NCP52 is the Functional Area 52 qualifying course. Initial priority is given to officer TDY enroute to a FA52 assignment or currently serving in a FA52 position. For availability, call the FA52 Proponent Manager at (703) 806-7866.

Hazard Prediction and Assessment Capability (HPAC)

HPAC provides the capability to accurately predict the effects of hazardous material releases into the atmosphere and the collateral effects of these releases on civilian and military populations. HPAC employs integrated source terms, high resolution weather and particulate transport algorithms to rapidly model hazard areas and human collateral effects.

Registration, Software Distribution and Training:
(703)-325-1276 Fax: (703) 325-0398 (DSN 221)

https://acecenter.cnttr.dtra.mil acecenter@cnttr.dtra.mil

Introduction to Combating WMD

This course introduces students to US Government and Department of Defense combating WMD (CWMD) strategy, policy and operations.

16-18 Oct 2007 – NCR
8-10 Apr 2008 – NCR

Locations:
National Capitol Region (NCR) and Defense Nuclear Weapons School (DNWS)
Albuquerque, New Mexico

Advanced Planners Course for Combating WMD

Apply aspects of the Joint Operational Planning Process and Effects Based Approach to Joint Operations to plans and operations relating to Combating WMD.

10-14 Dec 2007
Location:
Tyson's Corner, VA

Registration (DNWS):
505-846-5666
246-5666 DSN
DNWS@abq.dtra.mil

Online Registration:
https://dnws.abq.dtra.mil/StudentArea/AdmissionsForm.asp

These courses are available as a mobile training team (MTT) to any COCOM location.

Pantex Plant Operations

Participants will learn about nuclear weapon (programmatic) high explosive operations and tests, the US nuclear weapon complex, nuclear weapon design history, production operations, and US nuclear weapon dismantle issues. This training course will provide educational overviews and tours of actual facilities and equipment used in the US nuclear weapons production, transportation, and storage process. This course will also provide an overview of the CI threat to the nuclear weapons operations at the Pantex Plant.

There is no tuition charge, agencies are responsible for their trainee's travel and per diem expenses. This workshop consists of lecture sessions and Plant tours and demonstrations. All workshop sessions are conducted at the Pantex Plant, Amarillo, Texas. There are two scheduled workshops:

18-21 September 2007
30 October—2 November 2007

Registration Deadline: 60 days before course date; participants will receive reporting instructions 30 days before course start date

For further information please contact the Training Coordinator at (865) 574-9226.

WMD Terrorism

This workshop provides a basic overview of the technical and terrorist threat aspects of nuclear, chemical, and biological weapons.

Participants will be introduced to the various Federal Response Elements and the role that each plays when responding to a WMD event as well as counterterrorism policy. The first day concluded with Trends in Terrorism Overview. Nuclear technology briefings on the infrastructure required to support a nuclear weapons effort will be provided. Production of materials useful for radiological threat devices will also be covered. Briefings on illicit nuclear materials and scams will lead to a threat analysis exercise (an analytical methodology useful for any WMD type threat). Technical briefings on the chemical, and biological terrorism threat, materials and methods, and agents and effects are followed by a demonstration of detection and personal protection equipment.

There is no tuition charge, agencies are responsible for their trainee's travel and per diem expenses. This workshop is conducted at Ft. Story, Virginia, September 10-13 2007.

For further information please contact the Training Coordinator at (865) 574-9226.

Army Knowledge Online (AKO) users: Electronic back issues available!

Open up AKO and type in: **Nuclear and Counterproliferation** in the Search for... dialog box on the right side of the web page. Following that you will receive a page showing all unrestricted content in AKO.

Select: Nuclear and Counterproliferation

This will bring you to the Nuclear and Counterproliferation page. Scroll towards the bottom and you will see *Combating WMD Journal*. There you can find back issues.

Do you have information to share with the "CWMD Community?"

Get it posted here. Send your input to
The editors at dcsg3@conus.army.mil

Note: The editor retains the right to edit and choose which submissions are printed.

Operation IVY was an atmospheric nuclear weapons test series held in the Atomic Energy Commission's (AEC) Pacific Proving Ground at Enewetak Atoll in the Marshall Islands during autumn 1952. This is a shot of IVY Mike, a surface burst on Eluklab Island with a yield of 10.4 megaton, detonated 1 November 1952.

Courtesy DTRA http://www.dtra.mil/newsservices/fact_sheets/display.cfm?fs=ntpr_ivy

Image: US Government

U.S. ARMY NUCLEAR AND CWMD AGENCY

Fort Belvoir, Virginia